THURSDAY, MAY 8, 1879

THE CHEMISTRY OF COMMON LIFE

The Chemistry of Common Life. By the late James F. W. Johnston, M.A., F.R.S., Professor of Chemistry in the University of Durham. A new edition, revised and brought down to the present time. By Arthur Herbert Church, M.A. (Blackwood and Sons, Edinburgh and London, 1879.)

IT is now a great many years since the writer of the present review first read the work which as edited by Prof. Church he wishes to introduce to the readers of NATURE. He has not forgotten the keen interest and pleasure which the book awakened in him as a boy, and which were re-awakened when a few weeks ago the new volume came into his hands. Though times have changed since this book was published—now twenty-five years ago—though we are now almost deluged with scientific manuals and primers, intended to gratify the growing taste for science, or rather, perhaps, to meet the needs of our quasi-Chinese examination systems, yet such books as Johnston's "Chemistry of Common Life," or the equally charming companion work, "The Physiology of Common Life," by the late G. H. Lewes, have not been superseded. Full of facts which it is often difficult to find elsewhere, written in a style which will charm the most fastidious, awakening at every step the reader's desire to know more of the subject which is treated of, these two works have always appeared to us very models of popular scientific writing.

To edit such a work as "The Chemistry of Common Life" so as to bring the book up to date without departing from the author's plan or awakening unpleasant comparisons, was by no means an easy task, and one which could only be discharged adequately by an easy writer, thoroughly conversant with chemistry, and not unfamiliar with physiology; the task has, we think, been admirably performed by Mr. Church, and we recommend the volume which he has edited as one eminently deserving of the study of the medical man and the student of physiology.

The first chapter treats of "The Air we Breathe." In it we find discussed the composition of the atmosphere, the mode of preparation, and properties of its constituent gases; the importance of the watery vapour of the air, the formation of rain and dew, and their many uses; the accidental constituents of the air. The second chapter is devoted to "The Water we Drink." Here we find discussed the properties of hydrogen, the differences between a chemical compound and a mechanical mixture, the powers of water as a solvent, the quantities of mineral matter in some river, lake, spring, and sea waters; the causes of the hardness of waters, the organic impurities of water, the solubility of gases in water, and the importance of the presence of oxygen in water in relation to the life of fishes, besides many other topics which cannot be enumerated.

As an example of the way in which interesting information is brought together and ingenious suggestions advanced, which are sure to arouse an inquiring spirit in the reader, we quote the following very characteristic discussion of the influence exerted by certain vegetable matters upon the organic matters of water, with an ingenious explanation of the mystery of the waters of Marah:—

"Well-waters sometimes contain vegetable substances also of a peculiar kind, which render them unwholesome, even over large tracts of country. In sundry districts the decaying vegetable matters of the surface soil are observed to sink down and form an ochreous *pan*, or thin yellow layer, in the sub-soil, which is impervious to water, and through which, therefore, the rains cannot pass. Being arrested by this pan, the rain-water, while it rests upon it, dissolves a certain portion of the vegetable matter, and when collected into wells, is often dark-coloured, marshy in taste and smell, and unwholesome to drink. When boiled, the organic matter coagulates, and when the water cools, separates in blocks, leaving the water wholesome and nearly free from taste or smell. The same purification takes place when the water is filtered through charcoal, or when *chips of oak wood are put into it.* These properties of being coagulated by boiling, and by the tannin of oak wood, show that the organic matter contained in the water is of an albuminous character, or resembles white of egg. As it coagulates, it not only falls itself, but it carries other impurities along with it, and thus purifies the water—in the same way as the white of egg clarifies wines and other liquors to which it is added.

"Such is the character of the waters in common use in the *Landes* of the Gironde around Bordeaux,[1] and in many other sandy districts. The waters of rivers and of marshy and swampy places often contain a similar coagulable substance. Hence the waters of the Seine at Paris are clarified by introducing a morsel of alum, and the river and marshy waters of India by the use of the nuts of the *Strychnos potatorum* of which travellers often carry a supply. One of these nuts, rubbed to powder on the side of the earthen vessel into which the water is to be poured, soon causes the impurities to subside. In Egypt the muddy water of the Nile is clarified by rubbing bitter almonds on the sides of the water-vessel in the same way.

"In these instances the clarification results from the iron compounds or the albuminous matter being coagulated by what is added to the water, and in coagulating, it embraces the other impurities of the water, and carries them down along with it. Salt, and many saline matters, have likewise the power of clearing many kinds of thick and muddy water. So long as the water contains but little dissolved matter, all its particles of mud remain a long time suspended. But the addition of almost any soluble salt, even in small proportion, will, as it were, curdle the impurities, causing them to collect together and to settle.

"These cases, and especially that of the sandy Landes of Bordeaux, and elsewhere, throw an interesting light upon the history of the waters of Marah, as given in the fifteenth chapter of Exodus—

"'So Moses brought Israel from the Red Sea, and they went out into the wilderness of Shur; and they went three days in the wilderness, and found no water. And when they came to Marah, they could not drink of the waters of Marah, for they were bitter: therefore the name of it was called Marah. And the people murmured against Moses, saying, What shall we drink? And he cried unto the Lord, and the Lord showed him a *tree*, which when he had cast into the waters, the waters were made sweet.'"[2]

The chapter on Water is followed by others which treat of "The Soil we Cultivate and the Plants we Rear," of "The Bread we Eat" and "The Beef we Cook." Under the heading of "The Beverages we Infuse" we find separate chapters allotted to "The Teas," "The Coffees," "The

[1] Fauré—*Annales de Chim. et de Phys.*, Septembre, 1853, p. 84.
[2] Exodus, xv. 22–25.

Cocoas," the natural history, the various modes of preparation, the chemical composition, the physiological action, and the dietetic uses being in each case satisfactorily and pretty fully discussed.

"The Sweets we Extract" have several chapters devoted to them, in which the chemistry of the sugars is treated of, and the various methods of preparing cane, maple, beet-root, and even manna and milk-sugar are fully described.

"The Liquors we Ferment" include "The Beers," "The Wines," and "The Brandies." Under each head we find an amount of general information relating to modes of manufacture, to chemical composition, and to habits of various nations, which is truly remarkable.

"The Narcotics we Indulge in" have eight chapters devoted to them, the subjects treated of being the following:—tobacco; the hop and its substitutes; the poppy and the lettuce; Indian hemp; the betel nut and the pepperworts; coca; the Siberian fungus, and the minor narcotics. Then follow "The Odours we Enjoy," "The Smells we Dislike," and "The Colours we Admire." The last-named chapter is entirely new, and we shall therefore notice it at somewhat greater length than its predecessors.

It appears to us rather a mistake to have classed the blood colouring matter under the heading of "The Colours we Admire;" beautiful though the colour of blood may appear to be to the physiologist, we doubt very much whether most persons would not object to the statement implied in the classification adopted. As the proximate principle which confers upon the coloured blood corpuscles their remarkable function as the oxygen-carriers of the body, it ought in our opinion to have been relegated to the chapter which treats of "What we Breathe and Breathe for." In connection with hæmoglobin, though not in the chapter now under discussion, we find one of the really few inaccurate statements with which we have to charge Mr. Church. "But if the carbon-containing substances derived from man's food are burnt throughout his body, and if this burning takes place because of oxygen brought from the lungs, how and in what forms, may we ask, are the products of this burning, being no longer of use, conveyed out of the body? The very hæmaglobin which has brought the oxygen carries away the chief product of the burning—namely, carbonic acid gas." This is not correct.

Hæmoglobin possesses no special power of absorbing carbon dioxide, and the greater part of this body as it is formed, is taken up by the liquor sanguinis in which it is held partly in a state of solution and partly of feeble chemical combination. We observe that Prof. Church applies to the blood colouring matter the term hæm*a*globin instead of hæm*o*globin. The second is the now universally adopted way of spelling the word; it is a barbarously coined word and can only be preferred to the etymologically more correct hæmato-globulin on the score of use and wont; the change made by Mr. Church is, however, surely no improvement, as it is the stem (*αἱματ-*) and not the nominative case (*αἷμα*) which should be incorporated in the compound word. In the words "hæmorrhage," "hæmorrhoidal," "hæmoptysis," we have at least the sanction of old usage given to the coiners of "hæm*o*globin."

After shortly describing hæmoglobin Mr. Church refers to Turacin, a very remarkable red colouring matter containing 8 per cent. of copper, which he discovered several years ago in the pinion feathers of the *Plantain-eaters*. "The existence of an animal pigment so rich in copper as turacin, offers many interesting problems for study. Traces of this metal seem generally diffused in most vegetables and many animals; but here are more than traces—weighable and visible quantities." The sheets of the book had probably passed through the press before the announcement of Dr. Frederique's recent discoveries had been made in reference to the blood of the octopus, which would otherwise have probably been noticed. Dr. Frederique, of Ghent, in the first place confirmed the observations made by previous writers as to the colour of the blood of the octopus; in this creature the arterial blood is blue, whilst the venous blood is colourless. On agitating the venous blood with oxygen or atmospheric air it becomes blue; conversely on treating the blue arterial blood with reducing agents or heating it in the vacuum of a mercurial pump it loses its blue colour. The colour is found by Frederique to be due to a complex body containing copper, to which he has given the name hæmocyanin, which appears to have an analogous constitution to hæmoglobin; like this body it is decomposed easily and yields a proteid body and a colouring matter which contains all the copper of the original substance. This copper containing proximate principle is dissolved in the plasma and is undoubtedly the oxygen carrier of the blood of the octopus.

The chapter on "The Colours we Admire" closes with a succinct account of the synthesis (by Graebe and Liebermann) of alizarin, the madder pigment, and by a notice of recent researches on the constitution of certain of the coal-tar colours.

Did space permit we should notice the concluding chapters, of which some are mainly devoted to certain physiological topics, others to a recapitulation on "The Circulation of Matter." We trust, however, that the sketch which we have given will suffice to give some idea of the wide scope and deep interest which attaches to Mr. Church's admirable edition of "The Chemistry of Common Life."

A. G.

SILURIAN FOSSILS

A Monograph of the Silurian Fossils of the Girvan District in Ayrshire, with Special Reference to those contained in the "Gray Collection." By H. Alleyne Nicholson, M.D., D.Sc., F.R.S.E., Professor of Natural History in the University of St. Andrews, and Robert Etheridge, Jun., F.G.S., Acting-Palæontologist to the Geological Survey of Scotland. Fasciculus I. *Rhizopoda, Actinozoa, Trilobita*. Pp. 135, Pl. i.-ix. (Blackwood and Co., 1878.)

THE authors of this monograph state in their preface that they have been enabled to undertake their task through the aid rendered to them by a grant from the Government fund administered by the Royal Society, and we cannot but feel in examining this first instalment of the result of their labour that the pecuniary assistance has been in this case exceedingly well bestowed.

The Silurian district of Girvan in Ayrshire is one that has attracted much attention from geologists, and considerable difference of opinion has existed as to the exact correlation of the several members of the formation as there exhibited with the equivalent English deposits. The fossils, though numerous, are often in a rather unsatisfactory condition as regards preservation, and it was most desirable that a careful study of all the known forms should be made by competent palæontologists. The richly stocked cabinets of Mrs. Robert Gray have furnished the larger part of the specimens described, and the completion of this first part of the work was rendered possible by the liberality of Mr. Gray.

The memoir commences with an account of the bibliography of the subject, which appears to be very full and complete, and then proceeds to the description of the lower forms of life. Any one who will take the trouble to compare the lists given by our authors with those previously published cannot but be struck by the large additions which are now made to the Girvan Silurian fauna. A single doubtful fucoid and four species of *Foraminifera* are described as occurring in the Girvan rocks, and among the latter is the remarkable *Saccammina carteri*, which is so excessively abundant in some of the Carboniferous limestones. This form has been recognised as identical with the Carboniferous type by Mr. H. B. Brady himself, and its existence in Silurian strata adds another example—one of great interest to geologists—of the wide range in time of some of the lower forms of life.

Among the corals from the Girvan area Messrs. Nicholson and Etheridge enumerate no less than twenty-two forms, some being old and well-known species, but the majority are new to science; indeed several new genera of Actinozoa are established in the present work. The specimens are usually in a bad state of preservation, a difficulty which has been to some extent overcome by the authors by the employment of thin sections. The fact which comes out most strikingly from the study of the Cœlenterate fauna of the Girvan beds is that the nearest analogues of the Silurian fossils of Scotland are to be found not in the English area but in the American. The same fact, it will be remembered, was made very strikingly manifest from Mr. Salter's studies of the fauna of the Silurian limestone of Durness in Sutherland.

Of Trilobites twenty-eight species are now described as occurring in the Girvan district, and among them several forms new to science have been detected.

As the present volume only contains the first part of the results of our author's labours we do not find a full discussion of the bearing of the palæontological evidence on the interesting question of the age of the several Girvan deposits. There can be no doubt, however, that both the Upper and Lower Silurian are there represented, though the exact correlation of the different members of the series can only be successfully attempted when the fossils have been more fully worked out.

The present fasciculus is illustrated by nine very well executed lithographic plates from the pencil of Mr. Charles Berjean. We congratulate the authors on the able manner in which they have executed this first portion of their task, and hope soon to have to record the appearance of other portions of this important monograph.

OUR BOOK SHELF

Natural History Rambles. The Sea-Shore. By Prof. P. M. Duncan, F.R.S. *Lane and Field.* By the Rev. J. G. Wood. *Underground.* By J. E. Taylor, F.L.S. *The Woodlands.* By M. C. Cooke, LL.D. (London: S.P.C.K., 1879).

THESE four handy little volumes are well put together, and seem to us decidedly superior to works of a similar kind with which we used to be familiar in our youth. The evident purpose of the volumes is not to teach their subjects systematically, but to lead those into whose hands they may fall to take an interest in the common objects of nature which may be met with in an occasional walk. For this purpose they seem to us well adapted, and the information they convey on the whole trustworthy. They abound in suitable and well-executed illustrations, and might appropriately be put into the hands of any one, old and young, whose circumstances would give him a chance of using them.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Brorsen's Comet

LAST night, May 3, I observed Brorsen's comet pass nearly centrally over the star DM, + 61°, No. 873. In the principal focus of the telescope were two straight bars, 43″ (seconds of arc) wide intersecting in the centre of the field. The bars are at right angles to one another, and were inclined 45° to the hour circle. With this arrangement it was easy, by moving the telescope gently about the polar axis (which is well adjusted), to determine the conjunctions in R.A. and in declination, while angles of position coinciding with the bars, and distances in parts of the breadth of a bar, could be estimated with considerable accuracy. In this manner I made the following observations of the position of the comet with reference to the star:—

Chronometer time. h. m. s.	Angle of position. °	Dist. ″	
10 2 59	260	33	Distance measured by beats of chronometer.
10 4 31	270	12	Ditto.
10 6 20	—	—	Star apparently central in comet.
10 7 30	320	10	Star a little right of centre.
10 11 30	0	—	Estimated conjunction in R.A.
10 16 0	45	16	
10 18 15	45	43	
10 20 30	45	65	

Projecting these observations on a chart of ruled squares, it appears that at 10h. 11m. 36s. (corresponding to 10h. 11m. 14s. G.M.T.) the comet followed the star 0·68s. in R.A. and was 12″ N. of it, while the nearest approach of the centre of the comet to the star was 7″ at about 10h. 7m.

The moon was shining with great brilliancy (being nearly full) and made the comet faint, reducing its apparent diameter to 1½ or 2 minutes. The star is given in the DM as of the 8·8 magnitude, but I think is underrated a little. While the comet was passing over it there was no sensible diminution of its lustre. The DM position of the star for 1855·0 is—

$$\alpha = 6h.\ 7m.\ 25s.,\ \delta = +\ 61^\circ\ 28'\cdot 9.$$

The light of the comet has diminished rapidly since April 4. It is now less bright than a 9th mag. star.

Blackheath G. L. TUPMAN

IT is to be hoped that while the comet remains with us the observations of Prof. Young (NATURE, vol. xix. p. 559), and of Mr. Christie (NATURE, vol. xx. p. 5) may be repeated and confirmed by those who possess telescopes of sufficient power.

May I trespass upon your space so far as to ask Mr. Christie to explain a little more clearly what the precise carbon bands are with which the bands in the comet-spectrum are coincident. He speaks of the less-refrangible edge of the brightest comet band coinciding with the corresponding edge of the green carbon-band at 5200—in the spectrum of an alcohol vacuum-tube—and then proceeds to remark that the bands in the spectrum of alcohol are identical with those in the spectrum of olefiant gas and of carbon-dioxide and carbon-monoxide. If we are to understand that all the gases are inclosed in vacuum-tubes, then it must be remembered that the spectrum they give is the second spectrum of carbon in which the brightest bands have the wave-lengths 5610·5, 5198·4, 4834, and 4505. But it appears from Prof. Young's comparison of the comet spectrum with the blue flame of a Bunsen burner, that the brighter band agrees with that of the first spectrum of carbon whose wave-length is 5165·5 within about the interval of the *b*-lines

$$(b_1 - b_4 = 5183{\cdot}0 - 5166{\cdot}7 = 16{\cdot}3).$$

The spectrum with which Huggins compared the spectrum of Comet II. 1868, and of Coggia's comet in 1874, was obtained by taking the spark in olefiant gas at the ordinary pressure, and is therefore again the first spectrum of carbon.

The following comparison will exhibit the uncertainty which I wish to have explained:—

	Position of least refrangible Edges of Bands.		
Brorsen's comet	5600	5200	—
Carbon spectrum I.	5634·7	5165·3	4739·8
Carbon spectrum II.	5610·5	5198·4	4834

May I suggest the following comparison: to bring up the occulting bar from the blue end of the spectrum till it just covers the brightest comet band, then to introduce into the telescope first the light from a Bunsen burner or blowpipe flame, and then that from a vacuum tube inclosing carbonic oxide.

If the comet spectrum is that of Carbon I., light will be seen in the second case, but none in the first; if it be that of Carbon II., no light will be seen in either case.

Giggleswick, May 5 WILLIAM MARSHALL WATTS

I CAN fully confirm Young's observation that the spectrum of Brorsen's comet is not now the same as that observed by Huggins in 1868, as figured in Roscoe's "Spectrum Analysis," p. 251. On the 28th and 30th I observed the spectrum with a Browning's "miniature spectroscope" on a 4½-inch refractor, and compared it with the carbon spectrum of a low gas flame, and found the three usual bands of the latter to coincide with the three bands of the comet as completely as my instruments would show. It was needful to use a wide slit. T. W. BACKHOUSE

Sunderland, May 6

Temperature Equilibrium in the Universe in Relation to the Kinetic Theory

I AM inclined to think I shall best answer Mr. W. Muir's letter by not disputing the vague charges of unsoundness he has brought against me, but in endeavouring to make more clear the position for which I contend.

The object of my paper (NATURE, vol. xix. p. 460) was to contest the necessity of supposing that existing physical principles must have been violated in past time. I sought to prove that there was no reality in this necessity, by showing that even from our present imperfect knowledge, an explanation for the existing state of things might be evolved consistent with principles which at present prevail. Perhaps I may do well to add a few words in order to elucidate a point which was not too clearly expressed.

For mere sake of illustration, let us imagine a spherical envelope which permits neither change of volume nor passage of heat, to inclose a space of diameter, say 10^{10} times the distance between the sun and Sirius. First, let all the matter within this space be at the zero of temperature. Second, let all the matter within our envelope be at such a temperature that it is entirely dissociated into discrete molecules. Between these two extremes there is room for any number of mean states in which matter might be more or less aggregated, or discrete, and my point was that the universe might actually be in one of these intermediate states. It should be scarcely necessary to observe that we have limited our space merely for the sake of fixing our ideas. All that we require is gained, if, instead of using the impermeable envelope, we surround our sphere with infinite space filled with matter in a similar condition to that which the sphere inclosed. It is important to note that the volumes must be taken large enough to form a fair sample of the general state of the universe. Prof. Clerk Maxwell has shown ("Theory of Heat," p. 328) that a demon existing inside a gas might find irregularity where to us giants all appears uniform. With respect to the universe, may we not be in the position of demons?

London, April 29 S. TOLVER PRESTON

Barometric Pressure and Sun-Spots

IN his letter to NATURE, vol. xviii. p. 567, on "Sun-Spots and Weather," Mr. Fred. Chambers has shown that the curve of mean barometric pressure at Bombay throughout the year varies with the inverted sun-spot curve. Taking this fact together with the commonly-received idea that the annual variation of barometric pressure in Central Asia is due to the corresponding annual variation of solar radiation, he thence concludes that "the sun is hottest about the time that the spots are at a maximum, and coldest about the time when they are at a minimum." Now, even if the validity of the logical process by which "secular" is substituted for "annual" in this argument be admitted to hold in a general way, have we any reason to suppose that the atmospheric conditions at Bombay, a marine station on a peninsula, can be adequately taken to represent those which prevail in the centre of the Asiatic continent, or that they approximate to the latter to any greater extent, or even as much as those at St. Petersburg, for example?

On the other hand, if conditions which presumably reach their maximum intensity in the centre of the continent are so distinctly marked at such a distance from it as Bombay, they should at least be visible to some extent at St. Petersburg, which is certainly more continental in position, if not actually nearer the centre of the continent than the former city.

Such being the case, I should be glad to know how Mr. Chambers would account for the following remarkable fact, viz., that the mean annual barometric pressures at St. Petersburg from 1822 to 1871 show a well-defined relation to the sun-spots *precisely the reverse* of that evinced by the figures for Bombay.

I might, if I had followed Mr. Chambers's example, have concluded, with as good grounds for my opinion, that "the sun is coldest when most spotted," and *vice versa*, but I prefer to wait until more extensive investigations have given us a sounder basis for induction than at present exists. Meanwhile, I place before your readers the figures on which my statement regarding the St. Petersburg pressures is based. The employment of a variety of methods of comparison has invariably given the same results.

In the following table the variations from the mean, expressed in millimetres, are compared with the sun-spots according to the plan recommended by Mr. Meldrum, and which for some purposes is superior to those generally adopted hitherto. For brevity's sake only the final columns are given:—

Mean Cycles

	Max. years in 5th line.		Min. years in 7th line.	
	Pressure variation in mm. (1822–71).	Sun-spots (1811–77).	Pressure variation in mm. (1822–71).	Sun-spots (1816–72).
1.	−0·52	−33·9	+0·15	+23·3
2.	−0·35	−23·4	+0·59	+14·5
3.	−0·48	0·0	+0·78	+ 4·8
4.	−0·24	+28·2	+0·63	− 5·6
5.	+0·44	+43·1	+0·29	−19·0
6.	+0·70	+34·2	−0·31	−32·5
7.	+0·80	+16·8	−0·83	−37·1
8.	+0·62	+ 0·2	−0·71	−25·4
9.	+0·34	−14·2	−0·40	+ 1·8
10.	−0·07	−24·2	−0·14	+30·9
11.	−0·88	−26·3	+0·23	+44·8

It will be noticed that the pressure epochs lag behind the sun-spot epochs in the same way as the air-temperature epochs determined by Dr. Köppen.

The figures for the pressure are taken from the Annals of the Central Observatory. The above relation was first brought to my notice by my friend, Mr. S. A. Hill, of Allahabad.

Mr. Chambers's notion that "if the winter rainfall of Northern India is really due to the cold of winter, we should expect it to be greatest when the sun is coldest" is partly

answered by the fact that, according to Mr. Hill, the epochs of heaviest winter rain are approximately those of *highest* mean annual temperature. E. DOUGLAS ARCHIBALD

Distribution of the Black Rat

MR. MIDDLETON'S letter in NATURE, vol. xix. p. 460, induced me to inquire whether the black rat still occurs in Dresden, the museum under my care possessing several specimens, which were procured on the spot several years ago. The streets where this rat then occurred being known to me, viz., Meissener-strasse, Alaun-gasse, Königsbrücker-strasse, all on the right bank of the Elbe, in Dresden-Neustadt, I inquired in many houses, offering a relatively high reward for a specimen, but hitherto in vain. The museum possessing further a specimen from a place called the Schenkhübel, about an hour's walk from the town, in the direction of the last of the above-named streets, I had traps put there, but also in vain; only the brown rat, *Mus decumanus*, could be procured.

Every two years a general rat poisoning being ordered by the magistrate of the town, I shall wait till the next one (March, 1880), and then try to state whether *Mus rattus* still lives in Dresden, as it no doubt lived here several years ago.

The museum possesses besides specimens from Mühlhausen, in Thuringia, and a series from Saxe-Altenburg; in the latter country I do not know the exact locality, the man—a dealer—who sent them, being very mysterious on this point, but I have indubitable evidence that it still lives there, and even is not rare on some spots. Knowing that it occurred some time ago in the brewery of Blankenhain Castle, near Crimmitzschau, in Saxony, I inquired there, but got the answer that for two years it has been replaced by *M. decumanus*.

Therefore, I am not sure that *M. rattus* still lives in the kingdom of Saxony, but I *am* sure that it occurs in the Saxon Duchies. I shall publish the results of my further inquiries in case they are successful.

From the Malay Archipelago I brought *M. decumanus*, but not *M. rattus*. I got specimens from North and South Celebes, besides other localities, but as the *Mures* in my collections are not yet definitely determined, I cannot give more particulars now. A. B. MEYER

Royal Zoological Museum, Dresden, May 3

Mice and Beetles

PERMIT me to ask, through the medium of your columns, if it is known whether mice kill the common kitchen black-beetle. I have been unable to find anything bearing upon this subject, but having observed that there is an apparent reduction in the number of beetles, or at least no increase in number while the mice are permitted to live, and also that the mice do not touch any articles of food in the kitchen, where they are somewhat numerous, I have been led to think that they prey on the beetles in some way. W. WORBY BEAUMONT

The Cause of Thunder

I HAVE lately seen it stated in a text-book upon electricity and magnetism that the phenomenon of thunder is not fully accounted for by any theory as yet brought forward. Whether this be so or not I am not sufficiently acquainted with the subject to say. I believe the commonly accepted theory is that a vacuum is created in the path of the electric spark and that the subsequent in-rush of the air produces the detonation. If, however, it be allowed that the electric spark is not a material substance, but merely a natural force or mode of motion, the possibility of this theory is at once disposed of.

It is a well-known fact that the passage of electricity in a high state of tension, through a mixture of oxygen and hydrogen, not only causes an explosion, but also causes the formation of water, and it seems to me that, given the existence of free oxygen and hydrogen in the region of the electric disturbance, the phenomenon of thunder is sufficiently accounted for.

Whether the normal amount of hydrogen in the air is sufficient to cause the stupendous noise of thunder I am not competent to judge, but if not I would suggest that the presence of an abnormal amount might be accounted for by the process of the electrolysis, which would probably occur between the two poles of the thunder-cloud before the tension became so great as to cause a rupture of the circuit and consequent discharge of the electric spark. I would also draw your attention to the fact that every thunder-clap is immediately followed by an increase in the quantity of water deposited in the shape of rain. Does not this point to the formation of water by the explosion of the gases?

As I myself am unable both from want of means and time to investigate the matter, I should be glad to find that someone better qualified had taken the subject in hand. It is a frequent experiment of Dr. Tyndall's to show his audience real clouds; I feel convinced that by following this line of inquiry he could give us a real thunderstorm. S. A. R.

The April Meteors

ON the night of the 20th these meteors were watched for between 10h. 45m. and 11h. 30m., after which the stars were obscured by a dense fog. During the ¾h. of observation 15 shooting-stars were counted, of which 4 or 5 only belonged to the shower of *Lyrids*. These were faint and somewhat slow, with slight trains and short paths. The radiant point could not be exactly fixed. Of the other meteors three were brilliant ($2 = 1$st mag. and $1 = 2$nd mag.), and moved with extreme swiftness from a radiant point at $286° + 23°$. They left bright greenish streaks, and were readily distinguished from the *Lyrids*, though the radiants lie near together. This new shower near β Cygni (Albireo) appears to form an important display at this epoch. I saw several bright, rapid meteors from it on April 20–21 last year, and determined the position of its radiant point from a number of shooting-star paths given in Dr. Weiss's two volumes of Austrian observations at $288° + 22°$ (20 meteors) for the period April 19–23 (see *Monthly Notices* R.A.S., vol. xxxviii. p. 396). It is further confirmed by a stationary meteor recorded by Palisa at Troppau on April 19, 1870, at $289°·4 + 26°·4$, and it will be advisable to look out specially for this prominent shower of swift, streak-leaving meteors during future returns of the *Lyrids*. The latter display has quite failed during the last few years. W. F. DENNING

Ashleydown, Bristol, April 22

Salmo salar and the Schoodic Salmon

UNDER date of March 13, in the course of remarks on a late report of the U.S. Commissioner of Fish and Fisheries, you express a wish for an explanation of the fact that a sea-going salmon (*Salmo salar*) was found among the Schoodic "land-locked" salmon. I take pleasure in supplying the explanation. The fish referred to were taken in Grand Lake Stream, which connects two of the Schoodic lakes, tributary to the St. Croix River, which discharges into an arm of the sea on the border between the United States and Canada. Before the obstruction of the St. Croix by mill-dams, there was nothing to prevent the ascent of the sea-going salmon to this stream, and it is among the traditions of the aborigines that they were formerly often taken here along with the small "land-locked" or fresh-water salmon. The sea-salmon they called Pl-láhm; the land-locked, Tag-e-wáh-nàhn; and though for many years the sea-salmon were almost wholly prevented from ascending the river by the mill-dams, they have not been entirely exterminated, and the upper waters have been rendered in a degree accessible to the remnant by means of fish-ways constructed within a few years.

The specimen taken was, at the close of the season, set free with the other captured fish, and doubtless returned to sea.

I will add that the latest studies of American ichthyologists on the subject have led to the conclusion that the Schoodic and other "land-locked" salmon are specifically identical with *Salmo salar* (*vide* Jordan, "Manual of the Vertebrates of the Northern United States," 1878, p. 357).

Grand Lake Stream, Maine, U.S.A., April 9 — CHAS. G. ATKINS, Asst. to the U.S. Commissioner, Fish and Fisheries

Intellect in Brutes

A FEW months ago I made the acquaintance of a dog, which, I think, is worthy of a place among the dogs, and cats, and rats, and mules that are helping the pages of NATURE to determine the degree and kind of animal intelligence.

"Priest's" is a hotel on the way from the Calaveras Grove of Big-trees to the Yosemite. In former years, on the arrival of the stage, the landlady would send the dog to the poultry yard to catch chickens for the tourists' dinner. Now the dog "takes time by the forelock." The stage is due at six o'clock. About

five o'clock the dog saunters leisurely down the road till he meets the stage, he then bounds back to the poultry-yard, catches chickens, bites their heads off, and takes them to the cook! The number of chickens he kills bears a relation to the number of passengers he saw in the stage.

A gentleman who was stopping at the hotel for a few days went into the woods one afternoon with a gun. When he returned the dog came to him in much excitement to see what game he had taken. Finding his hands and his bag empty the dog ran into the forest and returned in less than an hour with a bird, which he gave with an air of compassion to the unskilful hunter.

W. D. GUNNING

Waltham, Mass., April 18

ON THE EVOLUTION OF THE VERTEBRATA[1]

SEVERAL theories of the vertebrate skeleton have been promulgated during the last century, some of which have since been abandoned, and others greatly modified. About a quarter of a century ago, three great stumbling blocks were removed from the study of animal forms, by the discovery that the cell-wall was not essential as inclosing sarcode, by the removal of the old conceptions about the origin of species, and by the rejection of the vertebrate theory of the skull in its older and grosser form. In the present course, the lecturer wishes to give both an analytic and synthetic account of the vertebrate skeleton, to see if a consistent history cannot be given of every cartilage, bone, and joint, in the higher types.

A vertebrated animal is constructed of a chain of segments similar to each other, which are obsolete in the head, and in each of which there is a smaller dorsal tube, through which the continuous neural axis runs, and a larger ventral tube, which contains the digestive organs, heart, and main blood vessels. The neural axis swells into three main vesicles in the head, giving rise to the fore, mid, and hind brain. The skeletal structures are formed on a single median axis, the notochord, which lies directly beneath the neural axis, and which is arrested in the head close behind the fore-brain. The barrier, however, which would stop the growth forwards of the notochord, is not developed when its apex shrinks. By the time the embryo is fairly formed, a fold of the palatal skin has given rise to a sac which opens into the lower and hinder part of the fore-brain. This sac is the pituitary body, the manner of the development of which has been clearly made out by Mr. Balfour, in the sharks and skates, and corroborated by the lecturer in the snake, lizard, and green turtle.

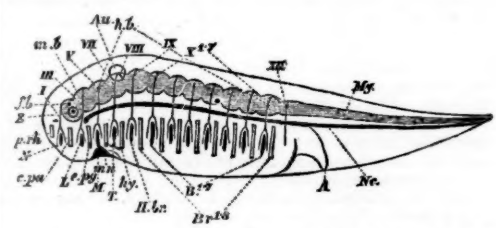
The mouth and posterior aperture do not exist at first, but are formed afterwards as involutions, which, in the latter case, at any rate, are not terminal, the alimentary tract extending behind the anus, and possibly in front of the mouth also in ancient forms. The visceral clefts appear as slits in the wall of the pharynx, and in the aquatic forms, give rise to the gills, while in the higher types (amniota), all of them close up but one, which remains as the tympano-eustachian cavity. The vertebræ alternate with the primary segmental masses. Each centrum, as it chondrifies, constricts the notochord, but there is usually some remnant of it to be seen in the adult in the invertebral spaces. The walls of the head are large and continuous, and its lower arches are generally small, clefts appearing between them. Both the arches and clefts become greatly modified in the adult, especially in the higher types. Thus the upper jaw is probably due to the modification and blending together of two or three pairs of arrested arches.

Besides the axial skeleton, a cartilaginous skeleton is developed immediately under the skin, and thus there is both a cartilaginous exo- and endoskeleton. The exoskeleton gives rise to the labial and extra-branchial cartilages, the limb arches and their limbs, and the intercalary cartilages of the median fins of fishes.

[1] Abstract of Prof. Parker's Hunterian Lectures, delivered at the College of Surgeons, commencing on February 10.

The bony parts of the skeleton are classified according to their relation to the axial or extra-axial cartilaginous skeletons. All bony scales, scutes, or sub-cutaneous bony plates, or tracts, are classified as exoskeletal; ossifications of the endoskeletal cartilage or its perichondrium are, of course, endoskeletal. Unfortunately for science, the extinct lower forms of the Vertebrata had their endoskeletons but slightly ossified, and thus only the outworks of their structure are left to us, as is the case with many of the Ganoids of the old red sandstone. The lowest of these, however, were half way up the vertebrate scale, if we compare them with the lancelet. Of existing brain-bearing fishes the lamprey and hag are the lowest, but man scarcely stands at a greater distance from them than they do from the lancelet, which, as far as we know at present, stands alone in creation.

Until we can connect the known Vertebrata, or at least their embryos, with the worm-like Invertebrata, the former will continue to be a very anomalous group. The difficulty is not with man; in him we have organ for organ and part for part, and he is better than a beast only by reason of something that cannot be demonstrated by the anatomist as such.



A, anus; *Au*, auditory capsule; B^{1-7}, branchial clefts; Br^{1-8}, branchial arches; *E*, eye; *e.pa*, ethmo-palatine; *e.pg*, epi-pterygoid; *f.b*, fore-brain; *h.b*, hind brain; *H.br*, hyo-branchial cleft; *hy*, hyoid arch *L*, lacrymal cleft; *M*, mouth; *m.b*, mid-brain; *mn*, mandible; *My*, myelon; *N*, nostril; *Nc*, notochord; *p.rh*, pro-rhinal; *T*, tympanic cleft. The Roman figures indicate the nerves.

The above diagram represents an ideal vertebrate, the oral, lacrymal, and nasal clefts being taken as homologous with the post-oral clefts. This theory seems probable both from the author's researches on the visceral arches and clefts, and those of Milnes Marshall on the nerves. The seven branches of the vagus (x^{1-7}) are here shown as separate nerves, and the hind brain as a series of enlargements.

As the relation of the endoskeleton to the exoskeleton does not usually seem to be properly understood, it may be as well to say a few more words about it. On the whole the foundations of the internal skeleton are laid in cartilage, and of the external in bone, which is formed by the ossification of fibrous tracts. The cartilage as a rule also ossifies, and this inner or *cartilage* bone has, so to speak, an organic affinity for the outer or *membrane* bone. But there are several things in the vertebrate exoskeleton that are formed of cartilage, as already mentioned; and in the endoskeleton the cartilage is often suppressed in certain parts, bony substance, formed in fibrous tissue, replacing it. Indeed, unossified fibrous tracts often take the place of cartilage. The welding together of parts originally distinct makes the matter much more complicated. No inherited elements are rejected by the morphological force; they are only kept from growing into special tissues until needed. Thus the rich growth of the human brain is covered in with a stout masonry that is merely made up of the inner layer of old ganoid plates, and the cartilages of the human nostril are inheritated from some ancient sucking fish, while the outer ear once figured, speaking morphologically, as the blow-hole of some Silurian shark.

A word or two must now be said about the different kinds of ossification. When the perichondrium, or clothing

of the cartilage, ossifies, it becomes the "ectosteal layer," and is directly related to the cartilage as its ossifying investment; this is a true endoskeletal lamina. Ossification of the dermis gives rise to "dermosteal" (exoskeletal) bony plates, such as the scales and scutes of fishes, and the scutes of reptiles and armadilloes. The intermediate fibrous tissue, especially in the region of the head, ossifies to form the splints, investing bones, or "parostoses" (exoskeletal). Lastly, the cartilage itself undergoes an osseous change, either by central, superficial, or subcentral "endostosis" (endoskeletal).

These species of ossification, like other species, are, however, apt to run into one another.

Fishes.—If we take a survey of the Vertebrata, beginning with the suctorial fishes, viz., the lamprey and hag, we find at first nothing but cartilage forming both the exo- and endoskeleton. The main peculiarities seen in the skeletons of these fishes are the peculiar cartilaginous labials, forming the sucking apparatus, and the basket-work of the "extra-branchials," which embrace the huge multiperforate pharynx. The Selachians (shark, skate, and Chimœra), although retaining much that is low and embryonic in their structure, are in many respects the highest and most reptilian of fishes. Their skeletal growths are uncombined; in their skin are numerous placoid grains or spines, forming the exoskeleton, while in the endoskeleton the first step towards ossification is seen in the calcification of the superficial cells of the cartilage. The labial system is now secondary, a more perfect mouth having taken the place of the sucking-apparatus. The basket-work of the sucking fishes yields bars to strengthen the mouths of the gill-pouches, the gill system being built upon large endoskeletal branchial arches. Limb-girdles, with their paired fins, appear in these fishes.

In the Chondrostei (sturgeon and paddle-fish (*Planirostra*), which are lower kinds of Ganoids, the slightly ossified cartilaginous endoskeleton is supplemented by outer bony plates, which, in the extinct forms, were often covered with an enameled layer. In the head, especially, these plates are conformed to the underlying parts, although they do not combine with them histologically. In this region they have also a constant tendency to a peculiar alternation of paired and unpaired elements. The scutes of the trunk, although suggesting the segments within, do not actually correspond with them.

Here we must look for the exemplars of our own investing-bones (*parostoses*) which are as yet, however, very generalized. The chondroskeleton now gets true ectosteal plates and sheaths, as well as parostoses.

But in those Ganoids that are called Holostei, the endoskeleton rivals that of the ordinary fishes in hardness, and yet the exoskeleton arrives at its highest pitch of perfection. In the head, the dermoskeleton is brought into adaptation to the more important architecture of the inner parts. The most perfect dermoskeleton is seen in the gar-pike (Lepidosteus).

The Dipnoi, which are in many respects related to the generalized chimœroids, show even less mutual adaptation of the outer to the inner skeleton than the sturgeon and paddle-fish, and, moreover, their bony skull plates are, as a rule, feeble, and few in number.

Lepidosiren and Protopterus have a few subcutaneous bones (parostoses) applied to a cranium which is almost entirely devoid of intrinsic ossifications, and scarcely advanced in development beyond that of a Chimœra. But Ceratodus has a helmeted head much like that of the lower Ganoids, the dermal scutes overlying the almost unossified cranium; it has also some sub-cutaneous bones.

The osseous fishes are the highest *as fishes*, but they are least of all related to those types which rise above them in the scale. Their metamorphosis is very great, but the elements are still uncombined. They have a copious growth of sub-cutaneous *bones*, as the Selachians have of sub-cutaneous *cartilages*, while in Ceratodus both are seen in an uncombined condition.

Amphibia.—The Amphibia are a subdivision of the Icthyopsida, which, like the Dipnoi, develop lungs as well as gills, but which often shed the latter, breathing only by the former. Their embryos, like those of fishes, develop neither amnion nor allantois. There are four orders in this sub-class, viz., the Cœcilians, the Urodeles, the Anura, and the Labyrinthodonts, the last of these being the large extinct Amphibia of the coal-measures. The living forms of Amphibia begin life as a sort of fishes, having gills; and, as a rule, they live in the water until they acquire lungs: some keep their gills, and continue to live in the water, while others shed them. The higher kinds undergo so much morphological change, and assume so many new and important characters, that they are perhaps the most instructive of all the Vertebrata.

In the Urodeles and Anura (tail-bearing and tail-less Amphibia) we find many things in common, and many more that are different. While they agree in possessing gills in their larval state, they differ in the character of their gills. The Urodeles have, some for a while, and others throughout life, three pairs of pinnate external gills, attached to the three first branchial arches, a single gill to each arch, there being generally a fourth arch which does not bear a gill. These are true *inner* branchial arches.

Amongst the frogs and toads there are three important modifications of the branchial system. In the common kinds (*Opisthoglossa*) there are at first free tufted gills growing from the two first, at least, of the four branchial arches, all of which are functional. These are soon hidden by an opercular outgrowth from the hyoid arch, which covers over and closes up all the branchial region, leaving, however, a small aperture on the left side. The primary pharyngeal wall not only splits so as to form four clefts on each side, but the wall itself becomes divided so as to form a series of pouches, each of which has a cartilage within and a cartilage without, the opercular skin loosely covering the pouches outside. The intra-branchial arches are small bars; the second and third extra-branchials are large bars, while the first and fourth are large pouches. Tufted vascular (*lophobranchiate*) growths, like those first seen outside, grow on the inside of the large pouches and bars, and also from the three branchial clefts, outside the extra-branchials. These latter correspond with the external gills seen in unhatched sharks and skate.

Dactylethra, one of the two existing *Aglossa*, shows no trace of external gills. The other, tongueless kind, *Pipa*, has probably very temporary rudiments of them. Suctorial cartilages have nearly disappeared in the embryos of Urodeles, but in the Batrachia they are nearly as much developed as in the lamprey. In the Urodeles we find no trace of a gill on the first and second arches behind the mouth, nor on the sixth, which exists in the majority of the species.

It is evident that the tailed Amphibia have been dropping from time to time parts no longer useful to them, whilst straining after a higher organisation. In them we have the beginning of the middle ear; there is a stapes and a fenestra ovalis. Here also a larynx appears for the first time, and the shoulder and hip girdles, and the fore and hind limbs are developed similarly to those of the higher types.

In neither Anura nor Urodeles is it possible to make a sharp distinction between a parostosis and an ectostosis, especially in the palate. The frogs and toads vary greatly in the intensity of their ossification; the parostoses pass into superficial dermal plates, and the bones, both superficial and deep, are apt to begin in a wild way, not keeping to the habitual landmarks. This is seen also to a less extent in Urodeles.

The mind of man is not able to invent a more wondrous

transformation than that which actually takes place in the life of every frog and toad. Born almost a lamprey, it changes into a creature which is a Selachian, and something more; for it passes through the further border of the sharks and skates, in their territory, and begins in its changing growth to make the rudiments, at least, of many an important organ which comes to its perfection in man and his nearest relatives. The growth force then fetching in improvements and additions from many a quarter, and combining all things skilfully, makes a new thing on the earth.

(*To be continued.*)

THE NEWEST EXPLOSIVE

GUN-COTTON and dynamite, which have for some years past held the foremost rank among modern explosives, are no longer, it seems, to retain this honour undisputed. A compound more violent still than either of these well-known preparations has lately been given to the world by M. Nobel in the shape of blasting-gelatine, and blasting-gelatine, again, has been endowed with still greater energy by a modification in its nature, effected by Prof. Abel, the War Department chemist. So far as experiment has shown, the gelatine and modified gelatine are, without doubt, the most active explosive agents known to us, or, in other words, a given weight of these compounds will work more destruction upon metal, stone, or other unyielding mass, than any of the hundred and one bodies of a like character with which we have become acquainted during the past half-century.

It is a well-known circumstance that, with but very few exceptions, the many explosives that have lately been brought before the public under a variety of names are merely modifications of one and the same thing. They are all nitro-compounds, or modifications of them. One class owe their origin to gun-cotton and the other to nitro-glycerine, and gun-cotton and nitro-glycerine are by the chemist regarded as the same thing. Gun-cotton is made by the nitrification of a solid body, and nitro-glycerine by the nitrification of a liquid body. The methods of manufacture are similar, and the agents employed to bring about the nitrification are the same. In the one instance a woody fibre—cellulose—is acted upon by a mixture of strong nitric acid and sulphuric acid, the former liquid to perform the operation of nitrification, by substituting certain equivalents of nitrogen for the hydrogen existing in the cellulose, and the latter acid for the purpose of absorbing any moisture given off in the substitution process, and thus preventing the nitric acid from becoming dilute and inefficient. In the other, a liquid—glycerine—is permitted to combine in small quantities at a time with a mixture of the same acids, and in like manner parts with its hydrogen, to be replaced by nitrogen.

There is, however, this wide difference in the application of the two compounds. Gun-cotton may be employed as it stands, and the Abel gun-cotton that is used by our soldiers and sailors for torpedoes and mining work is simply a pure pyroxilin, pulped fine to permit of its being thoroughly washed, and compressed into *papier-maché* sort of blocks, for the sake of convenience. Nitro-glycerine, on the other hand, being a liquid, is difficult to handle in that form, and for this reason it is that Nobel and others cast about for suitable vehicles to contain the preparation. A siliceous clay called Kieselguhr, which will absorb three times its weight of the liquid, has been found the most favourable substance, and dynamite, generally speaking, may be said to consist of 75 per cent. of nitro-glycerine and 25 per cent. of this inert substance. In lithofracteur, other substances besides, are employed, such as powdered charcoal and nitre, and there now exists a whole family of such combinations, none of which contain, however, more than 75 per cent. of the active explosive, nitro-glycerine.

In blasting gelatine, which, by the way, contains no gelatine at all, the objection to employing an inert material is got rid of altogether, and the mass, like compressed gun-cotton, is explosive and combustible throughout. Blasting, or explosive, gelatine is a mixture of nitro-glycerine and gun-cotton. M. Nobel, to whom is due the credit of having placed the valuable properties of nitro-glycerine at the disposal of mining-engineers, has discovered, in the pursuance of further investigations, that the liquid in question acts as a solvent upon gun-cotton. Like a mixture of alcohol and ether, nitro-glycerine is found to dissolve nitro-cellulose, and form a description of collodion, or, as M. Nobel terms it, gelatine. It is not, of course, the highly-explosive gun-cotton that will thus dissolve, but that known as photographer's pyroxilin, which does not contain so much nitrogen. Military gun-cotton, indeed, or tri-nitro-cellulose, to call it by its chemical name, should not be soluble at all, or at any rate only to a slight extent, if properly manufactured, and one of the tests to ascertain if it is of good quality is in fact to treat it with an alcohol-ether mixture to ascertain how far it will dissolve. The soluble gun-cotton, however, if not so highly nitrified, to coin a term for our purpose, is still a sufficiently explosive body, and this M. Nobel finds he can dissolve to a greater extent in nitro-glycerine than it is possible to do in alcohol and ether. Whereas the latter will dissolve no more than 4 or 5 per cent. of pyroxiline, and frequently less than 2, nitro-glycerine has been found to take up upwards of 7 per cent. The operation of dissolving is presumably done when the liquid is warm, and the result is, as we have said, a jellified mass, which has all the attributes of a definite combination. There is no separation of liquid from the mass, and cartridges may be made by simply rolling up the material in paper envelopes.

Thus, in blasting gelatine, there is no inert body, and the consequence is that weight for weight, the gelatine is superior in its destructive action to dynamite. The latter, as we have seen, contains 75 per cent. of nitro-glycerine, whereas blasting gelatine consists of from 90 to 93 per cent. of this liquid, and from 7 to 10 per cent. of soluble gun-cotton. But there exists another reason still, why the detonation of blasting gelatine should be more energetic, namely, because the combustion of the charge, from more perfect oxidation, is well nigh perfect. Prof. Abel pointed this out very clearly in his recent lecture at the Royal Institution. "As nitro-glycerine," he said, "contains a small amount of oxygen in excess of that required for the perfect oxidation of its carbon and hydrogen constituents, while the soluble gun-cotton is deficient in the requisite oxygen for its complete transformation into thoroughly oxidised products, the result of an incorporation of the latter in small proportions with nitro-glycerine, is the production of an explosive agent, which contains the proportion of oxygen requisite for the development of the *maximum* of chemical energy by the complete burning of the carbon and hydrogen; and hence," Prof. Abel concludes, "blasting gelatine should, theoretically, be even slightly more powerful as an explosive agent than pure nitro-glycerine."

By converting the gelatine into a more solid body by the addition to it of some 10 per cent. of military gun-cotton, or tri-nitro-cellulose, Mr. Abel appears to have secured a still more vigorous explosive, and one besides, that, by reason of its firmness, is more convenient to handle than the softer and pliant jelly. The destructive action of this modified gelatine upon iron plates and heavy masses of lead, has been found greater than that of any other form of nitro-glycerine or gun-cotton, and there is no room for doubt that for torpedoes and military mining, where the object is to secure the greatest degree of violence, regardless of consequences, the compound will find valuable application.

While on the subject of nitro-glycerine and its behaviour

as a detonating agent, a few words may be said upon the report of the Chief Inspector of Explosives that has just been issued by the Home Office. If only because it controverts a popular notion as to the dangers of this substance in a frozen state, the report in question is of considerable interest. Ever since the disastrous accident at Newcastle-upon-Tyne, when Mr. Mawson, the mayor of the city and several others lost their lives through the explosion of some packages supposed to have contained frozen nitro-glycerine, a wholesome dread of this substance has been entertained. But, strange to say, Major Majendie and Mr. E. O. Brown, of Woolwich, who appears to have been associated with the Chief Inspector in these experiments with frozen nitro-glycerine, found the latter far less sensitive either to blows or to fulminate powder than when in its ordinary condition. In some cases the frozen material allowed itself to be scattered by the violence used, without detonating at all, and it was only by using a very large charge of fulminate powder that its explosion succeeded. Frozen dynamite was still more obstinate, and under some circumstances, indeed, its detonation appeared almost impossible. Another circumstance of an unexpected character presented itself in these experiments. Mr. Brown found that the solidification of nitro-glycerine—a phenomenon that usually happens very readily some degrees above the freezing-point of water—is particularly difficult to bring about when the liquid is in a pure state. Continued subjection of the pure liquid to a temperature below freezing-point failed altogether to effect its solidification, and it was only upon the addition of a few grains of a solid body that the desired result was secured. The reason, therefore, why commercial nitro-glycerine so readily solidifies at a comparatively high temperature is obviously because it is not perfectly pure.

H. BADEN PRITCHARD

THE BRITISH MUSEUM LIBRARY

IN NATURE, vol. xix. p. 253, attention was drawn to the state of the literature of science as available for reference in the library of the British Museum. The publications of scientific societies, home, colonial, and foreign, and those of the scientific departments of different governments, were especially mentioned both as defective in regard to completeness of series, and as difficult to find in the catalogue.

Pending steps being taken to secure some approximation to completeness of series, which must take time, it may be useful to offer some suggestions with regard to the cataloguing, a modification in which would save much time to readers. Any fundamental alteration would no doubt be undesirable, for from a librarian's point of view, the cataloguing at the British Museum has been so often pronounced excellent. There is, however, also the worker's point of view, and if the catalogue is not one which, after years of experience he can easily use, it is not to be accounted as perfect.

The simplest solution of the present difficulty would be to have printed a separate list, such as the Patent Office periodically prints, "a list of the scientific and other periodicals and transactions of learned societies in the free library." Should there be, however, a financial difficulty in the way of carrying this out, it would be a saving of time to readers if these transactions, proceedings, &c., of societies were entered in some distinctive way, such as by a coloured ink, or even by a stroke in the margin, so that they might be easily picked out from bye-laws, lists of members, reprints of separate papers, &c. Several of the older societies occupy many pages in the special catalogue "academies." It is the publication of the societies containing the papers that are, of course, most frequently wanted, but these are so mixed up with other entries, that it takes time to find their press mark. Further than that, different series, when such exist, have different press marks, and it is not every one who has a date and a volume number for reference that knows whether there is more than one series, so a wrong press-mark may be given. In some cases there are two or three sets, more or less incomplete, of a series of publications, some, perhaps, in the King's library, some in the Granville, some in the general library, &c. This is very confusing, as it is only in a few cases that any note is made of the extent of incompleteness, and if the wrong set should be written for, it involves the loss of at least half an hour, and on busy days probably an hour.

If all the serial publications of a society were given at the head of the entries of that society, or even if only marked in the margin as just suggested, it would save a reader much time in finding the press mark, and would also save still further time often by giving the press mark for the part of the series which contains the volume wanted.

There is another point which is worth consideration, and that is whether those who are known to use the library for purposes of research could not be in some way put on a different footing from those who go simply to read. It would not be an innovation, but only an extension of a principle already recognised. For example, if a reader wishes to consult certain MSS., he is taken into a separate room, if he wishes to consult some of the older or rarer books, there is another room for such purpose, and there is but little time wasted in bringing him what he wants. Students are admitted to the natural history collections on days when they are closed to the public. There are a large number of people who use the museum for other purposes than work. They write their letters, read their magazines and newspapers, go round among their friends and gossip, write a ticket for some interesting book of travel or a novel, and read bits of it in the interval of receiving visits. Not a few appear to go there for a rest. The objection to all this is that these people occupy seats, and it is becoming more and more difficult for a reader with many books out at once for consultation or search to find table space. It is a very trying thing for a writer with references to verify or to follow up, to see while he is waiting for his books that the time of attendants is occupied in fetching novels that can be bought at any railway book-stall, or pieces of music that can be obtained for a few pence. (It may be mentioned in passing that for the cataloguing of comic songs and dance music, the British Museum is unsurpassed in excellence.) It must require a strong sense of the immorality of making quotations or references second-hand, to give a man patience under the circumstances. If the works are wanted for reading there is of course no help but waiting.

Surely there might be some distinction made between those who go to the reading-room for systematic work, and those who go for amusement. The British Museum reading-room is something more than a library for Londoners; people come up to town on purpose to consult it. It is a national library. An average mechanics' Institute would supply the wants of many who now use the Museum, occupy seats there, and take up the time of attendants. There are other free libraries in London besides the British Museum.

If it is not found practicable to make a distinction for workers generally it might be worth while to try how it would do to have tickets of a special colour for "Academies" and that these should not be obliged to wait their turn with tickets for novels. There are already white and coloured slips in use.

It would be a great advantage if the publications of societies and scientific departments of governments were kept all together and placed directly under the care of an officer who should see to their being kept up in completeness.

ON THE FIGURE OF THE EARTH

THE columns of NATURE recently contained an interesting series of articles on this subject, with notes. One of these notes, which I here repeat, has a

peculiar interest. The author says: "The theory was next propounded that the earth was an ellipsoid of three axes, but the proposition was not fully supported by the evidence." Upon this Col. Clarke remarks: "This is scarcely correct; the figure of three unequal axes agrees better with the observations than does the spheroid of revolution. But there is a necessity for this, and the ellipsoidal figure cannot be regarded as established."

I venture to think that this note ought to be printed in capital letters. It condenses, especially in the words, "but there is a necessity for this," the following important paragraph in the preamble to Col. Clarke's well-known paper in the *Memoirs* of the Royal Astronomical Society, 1861:—

"Whatever the real figure of the earth may be, if in the investigation we suppose it an ellipsoid, it is quite clear that the arithmetical process must bring it out an ellipsoid of some kind or other, which ellipsoid will agree better with all the observed latitudes, as a whole, than any spheroid of revolution will. Nevertheless it would scarcely, I conceive, be correct to say we had *proved* the earth not to be a solid of revolution. To prove this would require data which we are not in possession of at present, which must include several arcs of longitude. In the meantime it is interesting to ascertain what ellipsoid does actually best represent the existing measurements."

It may seem superfluous, so far as the main point is concerned, to add anything to these quotations: but of the three which have been given, I have very little doubt that the first was by way of a protest against the fallacy which, in spite of the last, has gained such a remarkable currency. Am I mistaken in thinking that it *is* a too-prevalent opinion that the equatorial section has been *shown* to be elliptical? It may be so; but I conceive it to be so noxious an error, when it does exist, that it is better to give too much than too little currency to every authoritative corrective of such an error.

It is very much to be regretted when investigations which are essentially *tentative*, and which are carefully guarded as such by sentences which are to be found if looked for, obtain through no fault of their own the character of demonstrations. I think Col. Clarke has run the risk of giving to the above fallacy a stronger hold by neglecting to emphasise with sufficient force, in his more recent calculations, their true character; and perhaps still more by seeming to entertain something of an expectation that the arithmetical result will be substantiated by increased data. Writing of the later result—as to which we may properly note that the equatorial major axis occupies a position differing from that of the former by 24° of longitude—he says: "But too much confidence must not be placed in it: as yet it is merely indicated by the existing observations, and the amount of the eccentricity of the equator shown is really very minute."

I am unwilling to seem to differ from so high an authority, especially on a point which I wish to have "reserved:" I therefore refrain from inquiring whether any such expectation is really entertained, preferring to adduce some arguments which tell the other way.

Whatever the real figure of the earth may be, it is as certain that, if we knew it exactly in every part—instead of only very uncertainly in a very few—a triaxial ellipsoid could be found which would fit it better than any other triaxial ellipsoid, as it is that a biaxial ellipsoid could be found which would fit a given egg better than any other biaxial ellipsoid. But we happen to know that eggs are generally egg-shaped, and not elliptical. So also we know—I hope it is not necessary to stop to prove this—that the earth is earth-shaped, and not ellipsoidal. If the best possible ellipsoid were fitted to it, the two would disagree everywhere more or less. It is not, therefore, as regards the present argument, a question of more data. If the figure were conformable to any ellipsoid, the existing data would suffice. Their insufficiency proves the non-conformity, and additional data cannot disprove it.

What additional data may be *expected* to do is to modify the approximate ellipsoid until the ellipticity of its equator disappears—in other words, until it becomes an elliptic spheroid.

Can I give any ground for this expectation? It would be fair to ask in return, Can any ground be shown for expecting a body, believed to have acquired its spheroidal form by rotation, to have an equator not circular? I will answer the latter inquiry first, myself. The same, or similar, causes which distributed land and sea irregularly have probably produced an equator which is not circular. But I know nothing to lead me to expect that the form of the equator has any better claim to be considered elliptical than circular, than this—an ellipse can generally be found which will fit an irregular area better than a circle. This argument can be turned against me, but only by admitting the irregularity. If the irregularity is admitted, I concede *an* elliptic equator for the approximate or mean figure. And the question is now reduced to one of degree.

The difference of equatorial semi-axes in Clarke's earlier investigations was 5,308 feet (1861), and subsequently 6,378 (1866). It is now 1,524 feet.

We are here, to go no further, within the limit of inequality assignable to the larger disturbances of sea-level; that is to say, to one kind only, of local irregularity.

In short, while I recognise with the most unreserved respect and admiration the labours which have resulted from the first attempt to ascertain whether a tri-axial ellipsoid was sufficiently indicated to be probable, I presume to think that Colonel Clarke's words of caution demand the utmost attention, and that the results at which he has arrived should be construed rather as disproving than as proving the reality of a sensibly elliptic equator.

I should extend this article too far if I did more than indicate one other ground for caution in describing the figure of the earth. Our knowledge on that head, as derived from arc-measures, is deceptive in proportion as we lose sight of the significance of the fundamental assumption that the figure is a regular one. Gross assumptions which suit an early stage of an inquiry may have to be abandoned later. The forms of the surfaces whose curvatures arc-measurements determine, are in any case local and particular; and so soon as local character appears, further consideration of the assumption is demanded. This, no doubt, is the reasoning out of which the tri-axial ellipsoid grew. It must not stop there. The tri-axial ellipsoid is not the only next step. Forced by the rigour of observation to abandon the elliptic spheroid as a final definition, and to admit irregularities as coming now within the range of more particular inquiry, the problem has in effect changed its face. To cling to the old assumption is to delay the recognition of the new phase. To look for additional data as means of substantiating or modifying an empirical modification of it is to halt in the presence of the larger problem which is opening before us.

Will it not be wiser to change the mode of attack? To bestow increased attention on the causes of irregularities and the probable magnitude of their effects? To theorise and calculate in this direction, on the one hand, and to extend experiment on the other, where such reasoning shall point the way? If we do this, the ultimate inadequacy of arc-measurements must receive recognition. The most obvious of all the causes of irregularity—the fluidity of the ocean and its obedience to the attraction of the land masses, must, one would think, invalidate their evidence materially. If, further, we consider the

actual conformations of the great terrestrial divisions of land and sea, arcs of longitude are, I imagine, especially likely to be affected by such causes.

The views which I have now attempted to express are by no means new, but it has not appeared necessary to cite authorities. I am indebted to many writers, but I should be sorry to have to assign to each the measure of the influence which his learning has had on the drawing up of this brief, which I hope some geodesist will now take up and argue more fully and more ably.

Dehra J. HERSCHEL

THE ROYAL SOCIETY SOIRÉE

ON Wednesday last week the President of the Royal Society gave a *soirée* at Burlington House, which was largely attended, and at which a considerable variety of apparatus were exhibited and many experiments made. Mr. Crookes showed his exhausted tubes and other apparatus, illustrating various phenomena connected with molecular physics in high vacua. The experiments made by these were the following:—

1. *Dark Space round the Negative Pole.*—When the spark from an induction coil is passed through an ordinary vacuum tube, a dark space is seen round the negative pole. The shape and size of this dark space do not vary with the distance separating the poles; nor, only very slightly, with alteration of battery power, or with intensity of spark. This well-known dark space appears to be a layer of molecular disturbance identical with the invisible layer of molecular pressure or stress, the investigation of which has occupied the exhibitor some years.

2. *The Electrical Radiometer.*—An ordinary radiometer is furnished with aluminium cups for vanes. The fly is supported by a hard steel cup, and the needle point on which it works is connected with a platinum terminal sealed into the glass. At the top of the radiometer bulb a second terminal is sealed in; the radiometer can therefore be connected with an induction coil, the movable fly being made the negative pole. At low exhaustions a velvety violet halo forms over each side of the cup. On increasing the exhaustion the dark space widens out, retaining almost exactly the shape of the cup; the bright margin of the dark space becomes concentrated at the concave side of the cup to a luminous focus, and widens out at the convex side. On further exhaustion, the dark space on the convex side touches the glass, when positive rotation takes place.

3. *Green Phosphorescent Light of Molecular Impact.*—At very high exhaustions the dark space becomes so large that it fills the tube, and when German glass is used the sides are beautifully illuminated with a greenish yellow phosphorescent light.

4. *Projection of Molecular Shadows.*—The rays exciting this green phosphoresence will not turn a corner in the slightest degree, but radiate from the negative pole in straight lines, casting strong and sharply-defined shadows from objects which happen to be in their path. The best and sharpest shadows are cast by flat disks, and not by narrow pointed poles; no green light is seen in the shadow itself, no matter how thin, or whatever may be the substance from which it is thrown.

5. *Magnetic Deflection of the Trajectory of Molecules.*—The stream of molecules, whose impact on the glass is accompanied by evolution of light, is very sensitive to magnetic influence, and the shadow can be deflected by bringing a small permament magnet near, the amount of deflection of the stream of molecules being in proportion to the magnetic power employed. The trajectory of the molecules forming the shadow is curved when under magnetic influence.

6. *Focus of Heat of Molecular Impact.*—Great heat is evolved when the concentrated focus of molecular rays from a nearly hemispherical aluminium cup is allowed to fall on a strip of platinum-foil, the heat sometimes exceeding the melting-point of platinum.

7. *Mechanical Action of Projected Molecules.*—An actual material blow is given by the impinging molecules. A small vaned wheel being used as an indicator, by appropriate means the molecular shadow of an aluminium plate is projected on the vanes. When entirely in the shadow the indicator does not move, but when the molecular stream is deflected so that one-half of the wheel is exposed to molecular impact it rotates with extreme velocity.

8. *Phosphorogenic Properties of the Molecular Stream.*—Substances known to be phosphorescent under ordinary circumstances shine with great splendour when subjected to the negative discharge in a high vacuum. (*a.*) *Becquerel's Luminous Sulphide of Calcium* shines with a bright blue-violet light, and when on a surface of several square inches, is sufficient to faintly light a room. (*b.*) *The Diamond* is very phophorescent. Most diamonds from South Africa phosphoresce with a blue light. Diamonds from other localities shine with different colours, such as bright blue, apricot, pale blue, red, yellowish green, orange, and pale green. One large fluorescent diamond gives almost as much light as a candle when phosphorescing in a good vacuum. (*c.*) *The Ruby* glows with a rich full red, and it is of little consequence what degree of colour the stone possesses naturally, the colour of the phosphorescence is nearly the same in all cases.

Besides these experiments the working of the writing telegraph, exhibited by Mr. E. A. Cowper, attracted much interest. The nature of this invention we described when it was first announced, and gave a specimen of the kind of writing produced. Other exhibits deserving notice were Prof. Guthrie's broken glass in frames, illustrating the fracture of colloids, Edison's loud-speaking telephone, Messrs. Preece and Stroh's synthetic curve machine, and frame of curves produced thereby; their automatic phonograph, electromagnetic vowel-sounder, stereoscopic curves, synthetic sounder and syren, and phonautograph. Apparatus and instruments of various kinds were also exhibited by Messrs. Browning, Hilger, and Tisley and Co. Among Mr. Hilger's exhibits was a quartz spectroscope for the ultra-violet rays, constructed for the Scientific Society of Stettin, under the direction of Dr. Schönn.

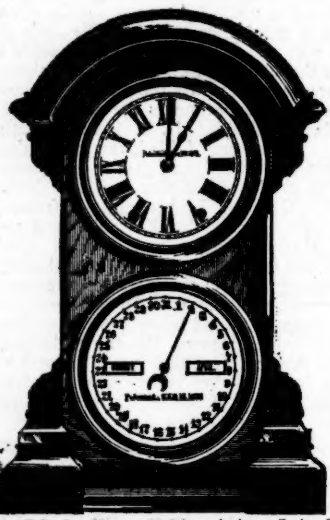
A NEW CALENDAR CLOCK

IT has always been a matter of surprise that the Americans can produce their well-known eight-day clocks in such large quantities, so uniformly good for ordinary purposes, and at such very moderate cost. Their general efficiency is proved by the increasing demand for them; not only are they sold in the American made cases, but separate movements are extensively imported and cased in England. One of the largest firms by which they are produced, that of Seth Thomas and Co., at Thomaston, Conn., has recently introduced a library or office clock of very moderate cost, one form of which is shown in the accompanying figure. This consists of the ordinary eight-day striking movement supplemented by an interesting and ingenious mechanism for operating the calendar; by its means not only the month and day of the week and month are indicated as in ordinary calendars, but the several months have their allotted number of days, an additional day being given to February in leap-year. Of course contrivances for effecting this object have long been known, but they always add so materially to the cost that they are prevented from coming into general use.

It would be impossible to fully explain the mechanism employed without the aid of drawings; a general description must therefore suffice. As will be seen, the calendar dial is placed below the clock dial, and is divided on its

circumference from 1 to 31. Two openings on a horizontal diameter allow drums to show the month and day of the week respectively, and a central hand points out the day of the month. A cam, formed like the snail of an English striking-clock, but without the steps, is caused to rotate once in twenty-four hours by the clock movement, so that a pendant, resting on it, is raised through a space of about 1 inch in that period and allowed to fall, the weight being supplemented by the tension of a spiral spring; this is the sole connection between the calendar and clock. During the ascent of the pendant a detent passes over one tooth of a wheel fixed to the week-day drum, which is thus carried round through a corresponding interval when the release occurs. At the same time a precisely similar action, performed on a wheel fixed to the axis that carries the hand, causes it to advance one figure.

Just as the cam driven by the clock accomplishes the change from day to day, so a second cam on the central axis of the calendar alters the month; the detent, on being released, carries forward one tooth of a 12-toothed wheel. It remains to explain the device for allotting the requisite number of days to each month and correcting

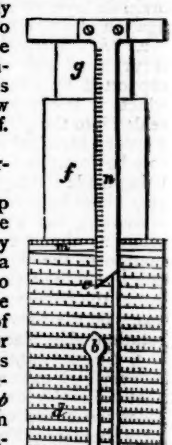


8-day Parlour Calendar, No. 4. Height 25 inches. Spring-Strike. 8-inch Dials.

for leap year. The axis of the month drum carries an irregular shaped cam, which may be conceived to be divided radially into twelve parts. Those arcs of the circumference that correspond to 31-day months are left untouched; 30-day months have their arcs filed away to the corresponding chord; and for February a depression is made equal to three times that of other months such as April. A light spring holds a bent arm against this cam, the arm being so placed that at the end of each short month it can ride on a metallic arc carried round with the hand; the acting length of this arc corresponds to one or three teeth of the dial-wheel if the 30th or 28th is the last day, and the arm entirely escapes it when thirty-one days are to be indicated. Whenever it is thus held out of its natural position, the arm prevents the check-spring that limits the movement of the dial-wheel from falling into its place, and the detent is thus enabled to advance the hand through two or four spaces instead of the usual one. An additional day is given in leap-year by a simple application of the well-known sun and planet wheel of Watt. The central fixed wheel is coaxial with the month-drum and has sixteen teeth; the planet-wheel, pivoted on the cam, has twenty teeth, and carries a sector of such a radius that, when superposed on the February depression, it diminishes the fall of the arm so that it rides on an arc corresponding to two teeth instead of three. It will be seen that the above numbers of teeth are so chosen that the wheel carrying this sector is only brought into an identical position once in every four (annual) rotations of the month-drum; the necessary correction is therefore effected.

SPIRAL SLIDE RULE[1]

THE method of multiplying and dividing by means of a rule was first introduced by Gunter about the year 1606 by the construction of a scale of two equal parts divided logarithmically, the readings being taken off with a pair of compasses. Oughtred about 1630 invented the rule composed of two similar logarithmic scales sliding in contact, but the difficulty of estimating the reading between two graduations then first became important. It is easy to see that it requires but little practice to place a graduation in one scale opposite to a position obtained by estimate between two graduations in the other scale, but it becomes a much more tiresome and uncertain process when both of the readings required to be placed in juxtaposition fall between two graduations on their respective scales. With practice, however, this operation can be effected with considerable accuracy provided the graduations are not too close together; hence to enable the calculations to be performed with a sufficient degree of approximation there has always been a desire to increase the scale and consequently the total length of the instrument. To attain this object and at the same time preserve the portable size of the instrument Prof. Everett designed his slide rule, but the range of this is now far surpassed by the invention by Prof. Fuller of the spiral slide rule.



The instrument can be readily understood from the accompanying figure.

d is a cylinder that can be moved up and down or turned round on the cylinder *ff*, attached to and held by the handle *e*. Upon *d* is wound in a spiral a single logarithmic scale. Two other indices, *c* and *a*, whose distance apart is equal to the axial length of the spiral, are attached to the cylinder *g*, which slides in *f* and thus enables the operator to place them in any required position relative to *d*. *o* and *p* are two stops which when placed in contact bring the index *b* to the commencement of the scale. *m* and *n* are two scales, one attached to the movable indices and the other to the cylinder *d*.

By the spiral arrangement the length of the scale can be made very great, and as only one scale is required the effective length is double that of an ordinary straight rule. The scale is made 500 inches, or 41 feet 8 inches long, and the instrument is thus equivalent to a straight rule 83 feet 4 inches long or a circular rule 13 feet 3 inches in diameter. The first three digits of a number are printed on the rule throughout the scale, much increasing the facility of reading off. The method of using the different indices will be best understood by examples. For multiplication—bring 100 to the fixed index *b* and place the movable index to the multiplicand,

[1] By George Fuller, M.Inst.C.E., Professor of Engineering, Queen's University, Ireland.

then move the cylinder so that the multiplier is at the fixed index. The product is read off at one of the movable indices, bearing in mind that the number of figures in the product is the algebraic sum of the number of figures in the multiplier and multiplicand, if it is not read upon the same index as the latter, but it is one less than that sum if read upon the same index. The use of the scales n and m is shown by the following: n being read from the lowest line of the top spiral and m from the vertical edge of the former. To find the value of 5^{13}: on placing c to 500 scale n reads ·68, and scale m ·01897, which gives ·69897 for the logarithm of 5. $\cdot 69897 \times 13 = 9\cdot 08661$. Next placing the cylinder so that it reads ·08661 on scales m and n the index c reads 12207, hence the required power is 1220700000 consisting of ten figures as required by the logarithm above. Where a considerable degree of accuracy is required we believe this slide rule will be found of much service, but it cannot compete on the one hand, on account of its somewhat cumbrous nature, with the ordinary patterns of slide rule for rough and ready work, or on the other with a table of logarithms for calculations requiring close approximation.

OUR ASTRONOMICAL COLUMN

A NEW NEBULA.—Dr. Tempel, of the Observatory of Arcetri, Florence, notifies his discovery of a nebula on March 14 in a part of the heavens which has been most rigorously scrutinised in searching for these objects. For this reason it was at first supposed to be a faint comet, and was compared with the seventh magnitude following, Weisse I. 305; but on March 16 its place was found to be unchanged. Dr. Tempel says it is properly a double nebula, with two small but distinct nuclei, distant from 15″ to 20″, and he adds the nebula Herschel II. 32, which is in the vicinity, was on both evenings much smaller and fainter than the new one. Herschel's nebula is caught at once in slow sweeping with a 6 or 7-inch refractor, so that an object to be very decidedly more conspicuous, must be within reach of ordinary telescopes, and it is hardly credible that its appearance can have long been as Dr. Tempel now describes it, without its being previously detected. Mr. Lassell's Catalogue of 600 new nebulæ discovered at Malta contains several in the immediate neighbourhood, so that the observer, Mr. Marth, could hardly have failed to have his attention called to the object in question, if then as visible as at present. Dr. Tempel's nebula is obviously worthy of immediate and continued observation; its position for 1879 is in R.A. 11h. 18m. 5s., N.P.D. 86° 1′·4, or it precedes the seventh magnitude above named 1m. 27s., nearly on the parallel. Chacornac, in his Chart No. 34, has a star 12·13 mag. within about 3′ from the above position, but shows no nebulosity; this circumstance is of itself sufficient proof that the nebula was not visible twenty-five years since. We would suggest that the position of this object relatively to the stars near it should be determined with all possible accuracy; it will be remembered that the centre of condensation in the variable nebula in Taurus has appeared to oscillate about the point where it was first remarked in October, 1852; or, to speak perhaps more correctly, nebulosity has at times been quite imperceptible in the original place, though apparent at a very short distance from it.

BRORSEN'S COMET.—In No. 2,254 of the *Astronomische Nachrichten* Dr. Armin Wittstein of Leipsic has given an orbit and ephemeris for this comet, founded upon a correction of the elements of Prof. Schulze by means of observations at Leipsic on March 19 and 26. There appears, however, to be error in the work; the new elements differing much from an observation on April 14, and so far as we can see, it is probable that the ephemeris for May, which has appeared in NATURE, will be much nearer the truth than Dr. Wittstein's figures; at the same time it is to be remarked that the predicted elements require sensible correction, though not to such an extent as his calculations would indicate. Were it considered worth while, an orbit might be deduced from the observations already made at the present appearance, which would afford the means of following the comet closely during the remainder of its visibility, but the predicted elements with a correction to the time of perihelion passage, will doubtless suffice for finding the comet readily, as long as it is within reach.

RE-OBSERVATION OF TEMPEL'S COMET, 1867 II.—In a communication to the Paris Academy it is announced that the comet of short period discovered by Dr. Tempel in 1867, and observed again at its return to perihelion in 1873 after experiencing heavy perturbation from the action of Jupiter, was found once more by its original discoverer, at the Arcetri Observatory on April 24. At 14h. 30m. Florence mean time, its R.A. was 16h. 50m. 59s. and its declination 13° 32′ south, so that its position corresponds nearly with that given in the first of M. Raoul Gautier's three ephemerides in *Astron. Nach.*, No. 2,242, in which the perihelion passage is assumed May 6·9416 Berlin M.T. Dr. Tempel says he had searched for it in vain during the rarely fine nights of February and March. The comet is faint and diffused, with a granulated appearance about the centre, and 2′ in diameter. This granular characteristic of comets, by the way, is one which has been frequently noted by Dr. Tempel, and which other observers do not appear to recognise so often. He directed particular attention to it when announcing his discovery of the comet of the November meteors, 1866 I.

If the perihelion passage of the comet 1867 II. be assumed to take place, 1879, May 6·9537 M.T. at Greenwich, and the mean diurnal motion = 593″·184, with the other predicted elements of M. Raoul Gautier, it is probable that the comet's position will be given very nearly during its present appearance. The co-ordinate constants in his orbit, for apparent equinox of June 1, are:—

$$x = r\,[9{\cdot}99389],\ \sin.\,(v + 328^\circ\ 2'{\cdot}4),$$
$$y = r\,[9{\cdot}95727],\ \sin.\,(v + 242\ 33{\cdot}4),$$
$$z = r\,[9{\cdot}65727],\ \sin.\,(v + 218\ 41{\cdot}7).$$

GEOGRAPHICAL NOTES

THE steamer *Nordenskjöld*, Capt. Sengstake, belonging to Herr A. Sibiriakoff, is almost ready to sail from Gothenburg for Behring Straits, *viâ* the Suez Canal, to search for the *Vega*, along with the *Jeanette*, belonging to Mr. Bennett, of the *New York Herald*. Herr Gregorieff, of the St. Petersburg Geographical Society, sails with the *Nordenskjöld*. Herr Sibiriakoff is sending off two coast searching parties to Behring Straits, one from Nischni Kolymsk and the other from the mouth of the Anadyr.

THE current number of the Royal Geographical Society's monthly periodical contains ample evidence of the good work which is being done by our missionaries towards making geography. Dr. James Stewart contributes an account of the second circumnavigation of Lake Nyassa, Dr. Laws a report of his journey along part of the west side of that lake, and Mr. G. Blencowe notes on the physical geography of Zululand and its borders, based on nineteen years' experience on the Natal and Transvaal frontiers. The geographical notes are fairly good, the more important being those which describe a new route from the Caspian to Kungrad, and recent explorations in Persia and Central Australia, but we cannot refrain from expressing our surprise that in a periodical, which ought to be the leading authority on geography, more space is not devoted to this department, the most important of all, for therein should be recorded brief accounts of all that is being done in the way of travel and exploration throughout the world. It will interest many of our readers to learn that the full text of

Prof. Geikie's able lecture on geographical evolution is promised for the June number.

WE understand that, chiefly through the instrumentality of a veteran Arctic officer, the Council of the Royal Geographical Society were some time back induced to urge upon H.M. Government the propriety of despatching a vessel to the relief of Prof. Nordenskjöld early in the present season. The matter, of course, was referred to the Admiralty, and "My Lords," after mature deliberation, have arrived at the conclusion that the matter had better be left to private enterprise. This resolution may be looked upon as a tolerably sure indication that the present Government are not disposed to embark upon an Arctic expedition of any description.

WE hear that Mr. Keith Johnston, the leader of the Geographical Society's East African Expedition, was to leave Zanzibar at the end of last month for Dar-es-Salaam, on the mainland, with the view of making final preparations for his journey to Lake Nyassa. The fact of his having been fortunate enough to secure the services of Chuma, Livingstone's old follower, will, no doubt, smooth away many difficulties, which otherwise would have caused him much trouble. Mr. Johnston has, we believe, turned his somewhat lengthy stay at Zanzibar to good account in the accumulation of all the information that could be procured respecting the tribes through which he will have to pass; and in this matter he has received very great assistance from an Arab named Bushire bin Selim, who is acquainted with some part of the country between the coast and Lake Nyassa, and who states that, though there is no direct road from the coast, the region at the north end of the lake is regularly visited by branch routes from the main road between Bagamoyo and Ujiji.

M. DE SEMELLÉ, whose death was we are glad to say prematurely announced, has succeeded in ascending the Niger and the Binué as far as Okeri, a point, it is stated, which has not hitherto been explored. He has collected valuable information on the products of the country, and the history and traditions of the people. He intends meantime to return to France for further subsidies to enable him to continue his exploration. M. Soleillet, who had to return to St. Louis in Senegal, after reaching Segou, is to set out on a new expedition for "Tichid, Wallatana, Timbuctoo, the Touat, and Algiers." M. Soleillet has brought back much interesting information concerning the people among whom he has been travelling, and of whom he speaks in very high terms for their intelligence and culture.

M. SAVORGNAN DE BRAZZA is about to set out for further exploration in the Ogowé region; he will endeavour to penetrate to the interior by the Alima and the river into which it falls.

IN No. 4 of the *Mittheilungen* of the Vienna Geographical Society, Count Stefanovic von Vilovo discusses the causes of the recent disastrous floods at Szegedin. Five years ago, it seems, he prophesied that some such catastrophe must happen, but he was only laughed at. He showed that this would be caused by the damming back of the water in the narrow rocky passes at Plocsa, and in the Kazan, in the narrow pass between Bazian and the Iron Gates, the surplus water being thus forced back into the nearest tributaries, the Morava, the Temes, the Save, and above all the Theiss. He maintains that the present disasters are solely the work of those rocks at Plocsa and in the Kazan, preventing the carrying off of the unusual quantity of water thrown into the river by the rains and snows of last autumn. Dr. Holub's paper on the Marutse-Mambunda is continued, with many illustrations and vocabularies, as also the papers of Prof. Benoni, on the sources of the Dniester, and Hesse-Wartegg's, on the river-bed of the Mississippi. Herr von Hochstetter contributes an illustrated paper on the magic instruments of the rain-maker among the natives of Inner Australia.

A LETTER from Herr Déchy, dated Darjeeling, March 9, in the *Mittheilungen* of the Vienna Society, states that in a day or two he expected to leave with a well-equipped expedition for exploration in Western Sikkim. He was to go through the valley of the Great Runget to the south foot of Kinchingunga; thence, climbing the Pundim-Nursing ridge into the Testa Valley, he was to explore the valleys, mountains, and passes of the Thlonok and Zemu rivers. Herr Déchy expects to add much to our imperfect knowledge of these regions, and his expedition is well supplied with instruments for scientific observation.

THE new number of *Les Annales de l'Extrême Orient*, which is doing good service by its translations of the accounts of Dutch explorations in Oceania, &c., contains remarks by H. von Rosenberg on the Schouten Islands at the entrance to Geelvink Bay, New Guinea, and brief notes by M. van Hasselt on Alahan-Pandjang in Sumatra, accompanied by a map. This periodical, it may be mentioned, records the proceedings of the Société Académique Indo-Chinoise.

WE understand that Prof. P. J. Veth, of Leyden, the learned president of the Geographical Society of the Netherlands, has been elected an honorary corresponding member of the Royal Geographical Society.

WE learn from the *Colonies and India* that a very interesting operation has been performed in the Thames River, New Zealand, viz., the blowing up of the Awotonga Falls, near the Awoka mountain. They were 75 miles from the mouth of the river, and had been a great hindrance to navigation. The falls were blown up with 200 lbs. of dynamite, the column of water rising to a height of 470 feet, and forming a magnificent spectacle. In addition to these falls, there have been removed in a similar manner several dangerous and impassable rapids and upwards of 500 "snags," varying from two to eight feet in diameter, and some of them 120 feet long. The clearing of this river, it is said, will open up a million acres of excellent land, which the Government have obtained from the natives.

TRENHAM REEKS

WITH much regret we record the death of Mr. Trenham Reeks, the esteemed Registrar of the Royal School of Mines, Jermyn Street. He had been ailing for some weeks, and last week the complaint assumed the serious form of inflammation of the lungs. There was still hope of his recovery a few days ago, but he expired on Tuesday morning, the 5th inst. By his death one of the oldest associations of the Geological Survey and School of Mines is severed. While still young he became connected with the infant museum established by the energy of his friend, Sir Henry de la Beche, in Craig's Court; and on the enlargement of that establishment and the creation of the School of Mines, he was appointed to the office which he has held up till now. Having in early life devoted himself to chemistry and mineralogy, he took great pride in the mineralogical collection under his charge in Jermyn Street, and from year to year enriched it with fresh acquisitions. He had a great knowledge of pottery, and gained it at a time when the taste was far less general than it is now. The illustrated hand-book which, in conjunction with De la Beche, he prepared of the ceramic collection in the Jermyn Street Museum, though long ago out of print, is still a valued work of reference. Personally, he was singularly courteous and obliging, though tenacious of purpose and not easily defeated in any matter wherein he had resolved to succeed. He thoroughly identified himself with the interests of the School of Mines, to which his loss must now be great.

Not a few who read these lines will long remember the

little, rather dingy, room in which, for well nigh thirty years, he has sat amidst blue-books, calendars, mineralogical specimens, and a rather orderly chaos of miscellaneous objects. They will think with sadness of the rupture of these old associations, and will follow to the grave with deep respect and sincere regret the old friend who has been so suddenly and unexpectedly removed from their midst.

WILLIAM GEORGE VALENTIN

It is with much regret that we record the untimely and sudden death on the 1st inst. from apoplexy of Mr. William George Valentin. He was born in Neuenburg, in the Black Forest, on May 16, 1829. He came to England in 1855, and, in the early days of the Royal College of Chemistry, studied under Dr. Hofmann, who esteemed him greatly, and, recognising his ability, made him senior assistant in the laboratory, a position which he retained at the Science Schools, South Kensington, under Dr. Frankland. He held for some years the office of gas examiner to the Great Western Gas Company, and at the time of his death was chemical adviser to the Trinity House.

His chemical text-books are deservedly popular; and within the last few days he corrected the final proofs of a new work which is therefore nearly ready for publication.

Mr. Valentin was a successful and painstaking teacher, and the fact that so many of the well-known chemists of this generation have received their early training from him, sufficiently indicates the value of his work; it would be difficult, indeed, to find one to whom the younger chemists of the present day are more indebted.

Within the last few weeks a few of his old friends and students of the Royal School of Mines had intended to present him with a testimonial; the efforts of the committee formed for this purpose will now be continued for the benefit of his widow and family.

ELECTRIC LIGHTING

We need not insist on the extreme importance and interest of the exhibition which was opened last night at the Albert Hall, and for which extensive preparations have been making for some time. The public mind both in this country and abroad has been recently much agitated on the question of electric lighting, and, as might be expected, people are much confused among the many systems which have been brought forward, and even those who know something of the subject must find it difficult to make up their minds. Hence the importance of bringing together the various systems of electric lighting in such a way as to make comparison possible. It must, moreover, have an important educational influence upon the general public, helping somewhat to give them a truer idea of what physical science is, and what it is capable of doing for the good of mankind. The exhibition was opened last night by an able and interesting lecture by Mr. W. H. Preece, the chair being occupied by the Prince of Wales.

The machines to be exhibited are not only those which have been recently attracting attention, but also older ones, which will exhibit in an impressive manner the history of the development of electric lighting. Thus there are in the arena of the Albert Hall specimens of Mr. Holmes's original magneto-electric machine, and of the Alliance Company's magneto-electric machine, lent by Trinity House, as well as the Siemens dynamo machine and the Gramme machine, now so much in use for generating electricity for lighting and other purposes. There are also varieties of the Gramme and Siemens machines, differing from each other more in minute detail than in general principle.

The Jablochkoff and the Lontin systems are also strongly represented. From the centre of the dome depend five large lamps of the Siemens pattern, round the upper corridor are ranged the Jablochkoff lamps exhibited by the Société Générale d'Electricité, and around the arena stand handsome specimens of the Lontin lamp, mounted on tastefully-designed posts. The Wilde lamp will also be strongly represented. This may be briefly described as the Jablochkoff candle with the central non-conducting substance left out. In addition to a powerful Gramme machine, the British Electric Light Company exhibit several lamps, notably the Serrin, hardly yet surpassed in some points of excellence, the Werdermann, Reynier, Higgins, and Rapieff lights, and it is stated that the Anglo-American Electric Light Company will exhibit the Wallace and the Iridium Incandescent lights, the last-named of which is of much the same kind as that employed by Mr. Edison. The distinguishing characteristics of these various lights were explained by Mr. W. H. Preece, and the exhibition, which will remain open to the public for the remainder of the week, promises to be by far the most attractive display of scientific apparatus made for some considerable time past.

It may not be inappropriate to give here a short account of a new form of electric lighting, which, it would seem, will not be represented at the exhibition now opened at the Albert Hall.

At last week's meeting of the Paris Academy, M. Jamin presented a model of an electric light for which he claims the greatest possible simplicity. The two carbons are kept parallel by two insulated copper tubes, separated by an interval of two or three millimeters, in which they slide by friction, and which serve at once to direct them and to guide the current. They are surrounded by a directing circuit composed of five or six spirals coiled on a thin rectangular frame ·40 m. long and ·15 m. broad. This circuit, traversed by the same current as the carbons, and in the same direction, guides and fixes the electric arc at the extremity of the points. The lighting is effected automatically. For this purpose, the two extremities of the carbons are surrounded by a thin caoutchouc band which keeps them close together. Between them, a little above, a small fragment of iron wire is introduced, which keeps them in close communication by a single point. As soon as the circuit is closed, the current traverses this wire, makes it red-hot, and melts the caoutchouc; the two carbons, thus freed, separate, and the arc is established with a sort of explosion. Carbons of any size may be employed, up to 8 mm. diameter. At this limit the waste scarcely exceeds ·08 m. per hour. By a proper arrangement the points may be maintained in their initial position. The apparatus may be suspended either with the points upwards or directed towards the ground. For several reasons, which Mr. Jamin states, the latter position is preferable. With its points downwards, then, M. Jamin claims for his light the following advantages:—1. That of simplicity, since it requires no mechanism and no preliminary preparation; all is reduced to a support and to carbons; (2) that of mechanical economy, since it succeeds in almost doubling the number of lights; (3) increase of illumination, since each of the new lights is nearly twice as powerful as the old; (4) quality of light, which is more white; (5) a more advantageous arrangement of the poles, which throw their greatest amount of light downwards, where it is required, instead of losing it towards the sky, where it is useless; (6) finally, economy of the combustible material, since the waste is less in proportion to the size of the carbons.

NOTES

We greatly regret to announce the death at Rome, on April 14, of Prof. Paolo Volpicelli, the well-known Italian electrician. We hope to be able to give details of his life and work in an early number.

THE Council of the Society of Arts have awarded to Sir William George Armstrong, C.B., D.C.L., F.R.S., the Albert Medal "because of his distinction as an engineer and as a scientific man, and because by the development of the transmission of power, hydraulically, due to his constant efforts, extending over many years, the manufactures of this country have been greatly aided and mechanical power beneficially substituted for most laborious and injurious manual labour."

THE annual *conversazione* of the president of the Institution of Civil Engineers has been announced for Monday, May 26. Mr. Bateman, the president, will, by permission of the Lords of the Committee of Council on Education, receive his guests in those galleries belonging to the South Kensington Museum which contain the varied and extensive collection of engineering, naval models, drawing instruments, and machinery. Mr. Bateman invites the members of the profession and others to supplement that collection by the loan for the occasion in question of any similar suitable object.

THE *American Naturalist* states positively that the President has nominated Mr. Clarence King to the directorship of the U.S. Geological Survey, and from an article by Mr. A. S. Packard, in the same number, there seems no doubt that the appointment has been confirmed. The actual state of matters now is that the three surveys under Hayden, Powell, and Wheeler are to be discontinued after June 30, and to be replaced by a new U.S. Geological Survey, in charge of Mr. Clarence King. "It was," Mr. Packard states, "as far as we are aware, the original understanding, when the matter was referred by Congress to the National Academy of Sciences, to simply consolidate the existing geological surveys, but the report of the committee was so worded that these surveys were abolished outright instead of being consolidated. The amount appropriated for the new geological survey is 100,000 dollars, a little more than each of the other surveys has formerly received. Thus the work is apparently to be greatly curtailed, and science and the best interests of the Western people will, in a corresponding degree, suffer." We trust that this is too gloomy a view to take of the prospects of the newly-organised survey, though we fear that personal interests have had more weight in bringing about the new state of things than the interests of science of the United States. We understand from Mr. Packard that no provision has been made for carrying on biological observation along with the geological survey, a department hitherto admirably represented, and the work of which has made the U.S. Survey famous all the world over. We are sure it will not be with Mr. King's consent that zoology and botany will be ignored in the survey under his charge, and he may be sure that men of science of all nations will watch with interest the future work of that survey which hitherto has contributed so largely to scientific knowledge.

THE death is announced of Mr. Frank A. Bradley, a well-known American geologist; he was crushed to death by the caving of a wall of a gold mine in Georgia.

THE United States Congress has appropriated 10,000 dollars for the completion of the investigation of the Rocky Mountains by the United States Entomological Commission. The work during the coming season will be carried on in Colorado and the Western Territories, particularly Utah and Eastern Idaho.

MR. S. H. BRACKETT, of St. Johnsburg Academy, Vermont, writes to the *Scientific American*, claiming for Mr. Edward Farrar, of Keene, N.H., the discovery of the principle of the telephone in 1851. In support of the claim Mr. Brackett gives the following extracts from Mr. Farrar's correspondence of the time:—"Each reed of a melodeon is furnished with a small metallic point, which, while the reed is at rest, approaches near to the surface of mercury in a very small cup underneath the reed, into which the point dips when set in motion. The reeds are connected with one pole of a battery, and the cups with the other. The current is broken with each vibration of the reed. At the remote end of the wire is a temporary magnet, with an armature fixed upon a spring in near proximity to the magnet, and which is affected as a reed at the other end of the line is set in motion. The effect is that the armature vibrates with the reed set in motion, and, the pitch of a sound depending on the rapidity of vibration, it will be the same in the reed and armature. A tune on the instrument will therefore produce a tune on the armature. What may appear somewhat strange, several different tones may be heard when chords are struck upon the instrument. The object of my inquiry was this: *If the current power could be varied by some slight variation of a vibrator to be affected by the atmosphere as the tympanum of the ear is, the supposition is that the sounds of the voice might be reproduced* by the means stated above." When it is remembered that Mr. Farrar penned the above in May, 1854, it is to be regretted, we agree with Mr. Brackett, that he was turned aside from so interesting an inquiry at so critical a point.

THE chief work now in process of publication by the United States Geological Survey, we learn from *Science News*, is Dr. Joseph Leidy's "Monograph of the Fresh-water Rhizopods of North America." It will form a quarto volume of several hundred pages, enriched by numerous plates, and will be the twelfth of the series of "Final Reports." The author has been long engaged upon this book, and brings to the elucidation of this subject unequalled knowledge of the branch of which he treats. The introductory chapter furnishes a general account of the rhizopods, giving the characteristics which serve to identify them, telling where they dwell, how they live, in what way to catch them, and the proper method for studying them under the microscope and otherwise. The class Rhizopoda, Dr. Leidy separates into five orders, as follows: Protoplasta, Heliozoa, Radiolaria, Foraminifera, and Monera. Dr. Leidy confines himself to those species which inhabit American ponds and rivers.

THE following questions are proposed by the Belgian Academy for competitive treatment (the rewards offered being medals of 800 francs value each, except for the third of the first section, where the value is raised to 1,000 francs):—I. Section of Mathematical and Physical Sciences—1. Show the state of our knowledge of phenomena known under the name of *influence of masses*, and indicate why the ideas of Berthelot have yielded to those of Proust; also indicate, if possible, the way by which a solution of the general problem may be arrived at. 2. Find and discuss the equations of some algebraic surfaces of no mean curvature. 3. Complete, by new experiments, the state of our knowledge of the relations which exist between the physical and the chemical properties of simple and of compound substances. II. Section of Natural Sciences—1. Give a description of the tertiary strata belonging to the eocene series, that is to say, terminated superiorly by the Laekenian system of Dumont, and situated in Hesbaye, Brabant, and Flanders. 2. Describe the history of the germinative vesicle in ova capable of developing by parthenogenesis. (The author is free to choose any animal species in which parthenogenetic development has been proved to exist.) 3. New observations on the relations of the pollinic tube with the ovule, in one or more phanerogams. The memoirs to be clearly written in French, Flemish, or Latin, and sent, with motto and sealed packet, to the secretary, before August 1, 1880. Great exactness required in citations. Two questions are also proposed for 1881:—1. New researches on the germination of seeds, especially on the assimilation of nutritive deposits by the embryo. 2. Extend to eight points of a curve of the third order, the enharmonic property of four points of a conic.

THE Carpi prize of the Reale Academie de' Lincei for 1880 (value 500 lire) will be awarded to the author of the best monograph *On the Organs and Vital Functions of Plants*. Memoirs to be sent in before December 31, 1880. The conditions are the same as in 1878.

A NEW nautical instrument, called a *navisphere*, has been brought before the French Academy by M. De Magnac. It is meant to indicate, without calculation and promptly, the names of the stars above the horizon at a given moment (with altitude and azimuth), the angle of route for going from one point to another by the arc of a great circle, and the distance between these points (approximately). Spherical triangles may also be solved with it. The instrument consists of two parts, the one a celestial sphere with stars marked on it, resting on a spherical zone, to which all possible positions may be given; the other comprises the system of the horizon, the meridian, and the vertical, represented by a circle, a semicircle, and a quarter of a circle in metal. With this system of arcs one can trace arcs of a great circle on the sphere, and measure their lengths, also measure the angles formed by two great circles. The second part of the apparatus is called a *metrosphere*. The experiments with the *navisphere*, made on board the Atlantic steamship *Washington* appear to have been highly encouraging.

IN the spectral examination of the new earth recently extracted from erbine by M. Nilson, M. Thalén found the following lines proper to the spectrum of that substance. (*Comptes Rendus*, March 24.)

Colour of rays.	Wave-length.	Intensity.	Remarks.
Orange	6078·5	3	Broad and nebulous.
	6072·5	3	
	6054·0	5	Nebulous.
	6035·0	2	
	6019·0	4	Nebulous.
Yellow	5736·0	6	
	5729·0	6	
	5719·0	4	Very fine and clear.
	5710·5	4	
	5700·0	4	
	5686·0	4	
	5671·0	4	
	5657·5	4	
	5526·0	2	Strong.
Green	5089·0	6	Fine.
	5084·5	5	
	5082·3	4	
	5081·0	3	
	5030·0	3	
Blue	4742·5	3	
	4739·0	4	
	4736·5	5	
	4733·0	5	
Indigo	4404·0	„	
	4373·0	„	
	4323·0	„	
	4319·0	„	
	4313·0	„	
	4245·5	„	

Besides these lines, several others were observed which belong to the spectrum of ytterbium, and which have already been indicated by M. Höglund in the spectrum of erbium. For the new element M. Nilson proposes the name *scandium*, to denote its peculiarly Scandinavian origin.

THE International Congress of Americanists has issued its circular of invitations to a third session, to be held at Brussels from September 23 to 26, under the patronage of the King of Belgium and the presidency of the Count of Flanders. The city of Brussels will take charge of the Congress, and see to the proper accommodation and convenience of the members. The object of this organisation is the development of a knowledge of the early history of discovery and settlement in the Americas, as also all such facts in their prehistory as can be gathered by an inspection of the remaining monuments. The volumes of *Proceedings* contain a great deal of interesting and important matter, although the Society is rather open to the charge of credulity in accepting, apparently without question, many statements repudiated by American archæologists. This, however, would be remedied by a larger representation from North America; and it is much to be hoped that some of our more accomplished American historians and ethnologists may take part in the proceedings of the coming season.

IT is known that the first aërial voyage was made by Pilatre de Rozier, in company with the Marquis d'Arlandes, in a Montgolfiere, or heated air balloon, on November 21, 1783. Pilatre was also the first victim of aërostation; he perished along with his companion Romain by the fall of a balloon at Boulogne. Three pieces which belonged to the unfortunate physicist are exhibited in the museum there: his speaking-trumpet, mercury barometer, and thermometer. Recently some other precious relics from the same origin have been found in a drawer in the museum. They are chiefly a plaster medallion of Pilatre, a part of the painted cloth which covered the gallery of the balloon, and the flagstaff. Engravings of these and the former relics of Pilatre are given in a recent number of *La Nature* (April 26), which also reproduces a detailed account of the fatal ascent.

THE extent of variability in composition of atmospheric air is a question treated by Herr von Jolly in a recent communication to the Bavarian Academy. By two methods of measurement, the one eudiometric, the other based on weighing, he observed variations that are not quite inconsiderable. The air samples of the year 1877 (got 2 km. out of town) showed differences in the oxygen from 21·01 down to 20·53 per cent., and in 1875 to 1876 the highest and lowest proportions (obtained by weighing) were 20·96 and 20·47 per cent. respectively. The variations in the two years were thus nearly the same. The largest amount of oxygen occurred in both years when the polar current was prevalent; the smallest with the equatorial current or föhn. It is not affirmed, however, that whenever the wind is north or north-east, there is necessarily *more* oxygen, and when it is south and south-west, *less*; or that differences of 0·5 per cent. occur with every reversal of the wind. The more rapidly the directions of wind alternate, there is more mixture of air masses; and therefore there is never so much oxygen as with continuous polar current, or so little as with continuous equatorial. Whether from year to year the mean proportion of oxygen is the same, or whether, as is more probable (the duration of polar and equatorial currents varying from year to year), there are slight differences in this average, can only be determined by further observations.

DURING the conjunction of the planets Mercury and Venus, on September 30 last year, measurements of their relative power of light-reflection were made at Strasburg Observatory (we learn from *Astr. Nachr.*) by Herr Schnur. The half-objective of the telescope which showed Venus was gradually shaded by measurable quantities till equal surface-portions of Venus appeared of the same brightness as those of Mercury through the unshaded part. The measurements on September 30 gave for relative light intensity the value 6·75, and on October 2 the value 5·36; the latter figure is considered the more reliable, and may be accepted for the relative brightness of Mercury and Venus. Herr Zöllner, by a quite different method, got 5·5.

APPLICATIONS for the intended Exhibition of Applied Science in Paris may be sent to M. Nicolle, director, 10, rue de Lancry, Paris. The presidency of the Patronage Committee has been accepted by M. Jules Simon. More than 200 English firms have already sent in their adhesion, and more than 300 German firms wish to protest against the abstention imposed by their own Government in 1878. A large number of these belong to

Alsace-Lorraine. The exhibition will keep open from July 15 to the end of November, but a limit will be imposed on exhibitors sending in their applications.

ON April 27 an earthquake was felt at Florence, and also at Bologna. The Florence commotion was very slight, but had been preceded by other movements of a similar nature, which ought not to pass unnoticed, especially in connection with the seismic manifestations felt in Germany, as mentioned in our last impression.

MR. ROWLAND WARD writing to the *Standard*, states that in making the excavation at Charing Cross for Messrs. Drummonds' new bank, the workmen, at depths varying from fifteen to thirty feet, came upon the fossil remains of various extinct animals. They include elephant tusks and molars (probably the mammoth *Elephas primigenius*), teeth and numerous bones of the gigantic extinct ox (*Bos primigenius*), a portion of the horn of the great extinct Irish deer (*Megaceros hibernicus*), along with various other remains of ruminating animals not yet identified. The specimen in this series which has specially attracted notice is the extreme end of a tusk unusually sharp at the point and highly polished, and from a portion of the surface of which a very thin skin of ivory peels off, exposing a strongly and regularly longitudinally channelled surface beneath.

MR. WATSON LYALL'S "Sportsman's and Tourist's Guide" improves every year. It has now reached its seventh year, and is evidently a great success. The information as to shootings, rivers, lochs, &c., of Scotland is as full as could be, and is evidently kept well up to date. It deserves all the success it has obtained. In this connection we greatly regret to see that the disease which we referred to last year as having broken out among the Solway salmon has reappeared this year, not only in the Solway rivers, but in the Tweed. Mr. Sterling, of the Edinburgh Anatomical Museum, found it to be a branching fungus (*Saprolegnia ferax*), which, first attacking the scaleless parts, rapidly spreads over the whole fish. The disease has not yet appeared north of the Tweed. Sir Robert Christison recommends a Royal Commission, and the careful watching of all salmon and trout streams, whether affected or not.

WE are glad to see from its Twenty-first Report that the East Kent Natural History Society is fulfilling its functions, though under many disadvantages.

WE have already referred to the forthcoming annual meeting, at Leicester, of the Midland Union of Natural History Societies. Those interested in the meeting will find further details in our advertisement columns.

IN Prof. Jevons's article (vol. xix. p. 588), second column, line 18, for "a seer is equal to about 21 lb. avoirdupois," read "a seer is equal to about 2 lb. avoirdupois." The error is a purely typographical one, and does not affect any other statements in the article. Mr. E. H. Pringle asks us to state that in his letter (vol. xx. p. 6), "such distances as six," &c., should be "such heights as six," &c., and "mountain 20,000 feet high (less than 4 miles)" should be "mountain 10,000 feet high (less than 2 miles)." He thinks it may be worth mentioning that Raoul or Sunday Island, in the Kermadaes, has an elevation of 1,627 feet, commanding a sea horizon of nearly 50 miles radius.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. E. Brett; a Pig-tailed Monkey (*Macacus nemestrinus*), from Java, presented by Mr. E. M. Clissold; a Black-faced Spider Monkey (*Ateles ater*) from Eastern Peru, two Passerine Ground Doves (*Chamæpelia passerina*) from America, presented by Capt. H. King; an Ocelot (*Felis pardalis*) from America, presented by Mr. B. H. Jones; a Crab-eating Raccoon (*Procyon cancrivorus*) from South America, presented by Mr. Bridget; a Long-tailed Marmot (*Arctomys caudata*) from Bhootan, presented by Capt. Greenstreet, R.E.; a Silver Pheasant (*Euplocamus nycthemerus*) from China, presented by Mr. E. J. Beagle; a Small Hill Mynah (*Gracula religiosa*) from South India, presented by Mr. J. W. Wodler; five Water Ouzels (*Cinclus aquaticus*), British Isles, presented by Mr. F. Swabey; an Anaconda (*Eunectes murinus*) from South America, presented by Mr. G. H. Hawtayne, C.M.Z.S.; a Teguexin Lizard (*Teius teguexin*) from South America, a Leopard Tortoise (*Testudo pardalis*) from South Africa, purchased; a Tamandua Ant-eater (*Tamandua tetradactyla*) from South America, a Great American Egret (*Ardea egretta*) from America, deposited; a Reeves's Muntjac (*Cervulus reevesi*) born in the Gardens.

RECENT CONTRIBUTIONS TO THE HISTORY OF DETONATING AGENTS[1]

II.

THAT the power possessed by different very highly explosive substances, of inducing the detonation of such bodies as gun-cotton and nitro-glycerine, is not solely ascribable to the operation of mechanical force very suddenly developed, is indicated not only by the singular inertness of gun-cotton to the influence of nitro-glycerine as a detonating agent, but also by a comparison of the behaviour of other detonating substances with that of the mercuric fulminate, when applied to the detonation of gun-cotton. Thus the detonation of silver fulminate is very decidedly sharper than that of the mercury compound, yet it is in no way superior to the latter in its power as an initiative detonating agent; indeed, a somewhat larger amount of it appeared to be required than of the mercury salt to induce detonation of gun-cotton with certainty. Again, the iodide and chloride of nitrogen are far more susceptible of sudden detonation than the silver fulminate; yet while 5 grains of the latter, confined in a stout metal envelope, suffice to detonate gun-cotton, 50 grains of chloride of nitrogen confined by water, appeared to be the minimum amount with which the detonation of gun-cotton could be accomplished with certainty, while no success attended the employment of confined iodide of nitrogen in quantities ranging up to 100 grains.

The incompatibility of these results with the general conclusion, based upon numerous and greatly varied experiments, that the facility with which the detonation of gun-cotton and nitro-glycerine, and bodies of a similar character as explosives, is induced by an initiative detonation, is proportionate to the mechanical force aided by the heat developed by the latter, led the lecturer to the conclusion that a synchronism or similarity in character or quality of the vibrations developed by the detonation of particular substances, operates in favouring the detonation of one such substance by the initiative detonation of a small quantity of another, while in the absence of such synchronism, a much more powerful detonation, or the application of much greater force, would be needed to effect the detonation of the material operated upon. This view has received considerable support from results since obtained by other experimenters, especially by MM. Champion and Pellet; but the subject is one which still needs further experimental elucidation.

The physical character of explosive substances, as also the mechanical condition of a mass of the particular explosive substance operated on, are of great influence in determining its behaviour when submitted to the action of an initiative detonation. The liquid nitro-glycerine is far more sensitive to detonation than gun-cotton; one grain of mercuric fulminate, confined in a metal case, suffices to detonate nitro-glycerine when surrounded by it; but, in order to attain this result with any degree of certainty, it is necessary so to confine the nitro-glycerine as to prevent its yielding to the blow developed by the initiative detonation, and thus to some extent escaping from the operation of the sudden concussion to which the particles contiguous to the fulminate charge are submitted.

If nitro-glycerine be mixed with solid substances in a fine state of division, plastic mixtures may be obtained, and the liquid may thus be presented in something like a solid form to the

[1] Weekly Evening Lecture at the Royal Institution, Friday, March 21, 1879. By Professor Abel, C.B., F.R.S. Revised by the Author. Continued from p. 21.

detonating agent; if the particles of absorbent material be, moreover, of porous nature, as is the case with the infusorial earth called kieselguhr, used in the production of dynamite, a solid nitro-glycerine preparation may be obtained which contains a very large proportion of the liquid (75 per cent. by weight). In this condition nitro-glycerine may be detonated without any difficulty when freely exposed to air; and although it is diluted with a considerable proportion of absolutely inert material, its sensitiveness to detonation is not in the least diminished. Each particle of the diluent is enveloped in the liquid, so that no portion of the latter becomes isolated from the remainder by the admixture of inert solid matter; hence, when the initiative detonator is surrounded by such a mass, it is in contact at all points with some portion of the nitro-glycerine, and the latter is in continuous connection throughout, though no longer in a mobile condition; detonation is consequently as readily established and transmitted through the mass as though it consisted entirely of nitro-glycerine. Indeed, while the liquid in its undiluted state, if freely exposed to air in a long layer, transmits detonation with difficulty, and very slowly as compared with compressed gun-cotton (the observed rate of progression being, in several experiments, below 6,000 feet per second), detonation is transmitted with ease and certainty through very long trains of a solid preparation of nitro-glycerine, such as dynamite, and the rate of transmission is decidedly more rapid than it is with compressed gun-cotton, a result which is in harmony with the greater sensitiveness to detonation and the greater violence of action of nitro-glycerine.

It has already been stated that gun-cotton may be detonated if a confined charge of not less than two grains of mercuric fulminate be detonated when closely surrounded by the substance. But in order to attain this result, the cellulose-product must be presented to the detonating agent in a mechanical condition favourable to its action.

Gun-cotton in a loose flocculent condition, or even if in the more compact form of a spun yarn or thread, cannot be detonated through the agency of a large charge of fulminate buried in the material. It is simply scattered with violence, portions being sometimes inflamed by the heat developed where the fulminate is detonated. If however, the gun-cotton be converted into a compact form, either by ramming the wool or thread very tightly into a case, or better still, by reducing the gun-cotton fibre to a very fine state of division, and then compressing it into compact masses, it becomes susceptible of detonation by the initiative action of mercuric fulminate, and the quantity of the latter required to bring about detonation is small in proportion as the compactness or density of the compressed material is increased.

Detonation, when established in compressed gun-cotton, is transmitted with great velocity throughout the mass, as already stated, or from one to another of contiguous masses, and even, though at a reduced rate, if small spaces exist between the individual masses. But, if a small mass of compressed gun-cotton freely exposed to air be detonated when in immediate contact with gun-cotton wool or loosely-twisted yarn, the detonation will not be transmitted to these, but they will merely be scattered and perhaps inflamed.

The difference in the behaviour of nitro-glycerine and of gun-cotton when presented to the action of a so-called initiative detonation under the different conditions spoken of above, admits of ready explanation.

It has been thoroughly established that the action of an initiative detonation is not ascribable to the heat developed within the detonating material itself, in undergoing chemical metamorphosis. Its action has already been compared to that of a blow from a hammer or falling weight. The readiness and certainty with which gunpowder, gun-cotton, and other explosive agents are detonated by the latter agency are regulated by several circumstances; they are in direct proportion to the weight of the falling body, to the height of its fall, and to the force with which it is impelled downwards; to the velocity of its motion; to the mass and rigidity or hardness of the support upon which the substance to be detonated rests; lastly, to the quantity and mechanical condition of the explosive agent struck, and to its sensitiveness.

Gunpowder is much more readily detonated by a sharp blow from a small hammer than by the simple fall of a heavy hammer, or by a comparatively weak blow from the latter. It is very difficult by repeated blows, applied at very brief intervals, to detonate gun-cotton if placed upon a support of wood or lead, both of which materials yield to a blow, the force applied by that blow being transferred through the explosive agent and absorbed in work done upon the material composing the support. But if the latter be of iron, which does not yield permanently to the blow of the hammer, the detonation of those substances is easily accomplished. If the quantity of the explosive agent employed be so considerable as to form a thick layer between the hammer and support, the force applied is to so great an extent expended in imparting motion to the particles of the compressible mass, that there remains little or none by which its detonation can be accomplished, and if the material be in a loose or porous condition (as in the case of a powder or of loose wool), much work has to be accomplished in moving particles of the mass through a comparatively considerable space, in the operation of compressing them, so that a second or even a third blow is required for their detonation; whereas if, by blows or pressure previously applied, the explosive material will be presented in the form of a compact mass, the particles of which have little tendency to motion when force is applied to them, detonation will be much more readily developed. It appears, therefore, that the detonation of an explosive substance by means of a blow is the result of the development of heat sufficient to bring about most energetic chemical action, or change, by expenditure of force in the compression of the material, or by establishing violent friction between its particles, consequent upon the motion momentarily imparted to them, and that it is brought about with a readiness proportionate to the resistance which they oppose to their motion by the degree of their contiguity to each other.

The exceedingly violent motion of particles resulting from the sudden or extremely rapid transformation of a solid or liquid explosive body into highly heated gas or vapour (which is the effect of a detonation), must obviously exert force which operates upon a body opposed to it in a manner precisely similar to the force applied by opposing a body in the path of a solid mass which is set into very rapid motion. The power of accomplishing the detonation of nitro-glycerine, gun-cotton, or other highly explosive substances, freely exposed to the air, through the agency of detonation produced in their vicinity or in close contact with them, appears therefore correctly ascribable to the heat suddenly developed in some portion of the mass by the mechanical effect, or blow exerted by that detonation, and is regulated by the violence and suddenness (either singly or combined) of the detonation, by the extent to which the particles composing the mass of the explosive material are in a condition to oppose resistance to the force, and by the degree of sensitiveness of the substance to detonation, or to sudden metamorphosis, under the influence of heat thus developed.

It will now be evident why the readily yielding nature of the particles of liquid nitro glycerine tends to counteract its great sensitiveness to detonation, and why, when the motion of the liquid particles is impeded by their admixture with solid matter, and when they are consequently placed in a position to resist mechanical motion by the force applied through the agency of detonation, its natural sensitiveness to detonation, and the rapidity with which it can be transmitted from particle to particle become fully developed.

Again, the reduction of gun-cotton fibre to a fine state of division, which renders the material readily convertible into very compact and dense masses, places the particles in the condition most favourable to resist mechanical motion upon the application of a blow, or of the concussion resulting from a detonation; hence, compressed gun-cotton is readily susceptible of detonation in proportion to the extent of compression, or to its density and compactness, while loose gun-cotton wool, or the lightly twisted or compressed material cannot be readily detonated, because the force applied is expended in imparting motion to the readily yielding particles of the mass. If the force applied through the agency of a detonator to a mass of explosive material just borders upon that required for the development of the detonation, or if the condition of the mass is such as hardly to present the requisite resistance to mechanical motion essential for its detonation, then, results intermediate between the mechanical dispersion of the mass and its violent chemical dispersion or disintegration, *i.e.*, detonation, are obtained. Thus, frequent instances have been observed, especially in the experiments in the transmission of detonation through tubes, in which the initiative detonation has brought about an explosion attended with little, if any, destructive effect, portions of the mass being at the same time dispersed and occasionally inflamed. Even silver fulminate, which under ordinary conditions detonates

violently, even when only a particle of the mass is subjected to a sufficient disturbing influence, has been exploded without the usual demonstrations of force, by the transmitted effect of a detonation of mercuric fulminate. In these instances the violence of the concussion produced by the initiative detonation was only just bordering on that required for the development of detonation, and it appears probable that only some small portion of the mass operated upon was in a condition or position favourable to the action of the initiative blow. The remainder of the mass would then be dispersed by the gases developed from the detonated portion; in some instances the particles would be inflamed at the moment of their dispersion, in others, they would even escape ignition.

Some experiments made in firing at masses of compressed gun-cotton, differently arranged and of different thicknesses, with a Martini-Henry rifle, at short ranges, afforded interesting confirmation of the correctness of the explanation given of the operation of a blow upon masses of explosive material under different conditions. Disks of gun-cotton of the same density and diameter, but differing in thickness, were fired at; they were freely suspended, and their distance from the marksman was in all instances 100 yards. The thinnest disks were simply perforated by the bullets; somewhat thicker disks were inflamed by the impact of the bullet, while still thicker disks, fired at under the same conditions, were exploded. No instance of detonation was, however, obtained. These differences in effect, obtained with masses of different thickness and weight, are due to the difference in their power to resist mechanical motion when struck by the bullet, and in the different amount of resistance to penetration presented by the thin and the thicker disks.

It has been explained that nitro-glycerine may be largely diluted with inert solid matters without its sensitiveness to detonation being reduced, while its detonation in open air becomes very much facilitated, because the tendency of its particles to yield to the force of a blow or detonation, is very greatly diminished. But if a *solid* explosive agent is diluted with inert *solid* matter the case is different; for in such a mixture of the finely divided solid with non-explosive solid particles, there must be a partial and sometimes a complete separation of the particles of the explosive by the interposed inert particles with which it is diluted; hence the sensitiveness to detonation is reduced, and its transmission by the particles is retarded or altogether impeded, by a diminution of the extent of contact between the substance to be detonated and the initiative detonation, and by the barrier which the interposed non-explosive particles oppose to the transmission of detonation. In experiments made in this direction with finely divided gun-cotton, it was found that although dilution with an inert solid, applied in the *solid form*, reduced the sensitiveness of the material to detonation, this was not the case when it was incorporated with a salt soluble in water, the mixture being then compressed while in the wet state. The compressed masses thus obtained were, when dried, in a condition of greater rigidity than could be attained by submitting undiluted gun-cotton to considerably more powerful pressure, because the crystallisation of the soluble salt used as the diluent upon evaporation of the water, cemented the particles composing the mass more rigidly together. The gun-cotton was therefore presented in a form more capable of resisting the mechanical action of a small charge of fulminate, than a more highly compressed undiluted gun-cotton, and hence the reduction in sensitiveness due to the detonation of the explosive compound is nearly counterbalanced by the greater rigidity imparted to the mass. If a soluble oxidising agent (a nitrate or chlorate) be employed as the diluting material, the predisposition to chemical reaction between it and the gun-cotton (which is susceptible of some additional oxidation), appears to operate in conjunction with the effect of the salt in imparting rigidity to the mixture, thus rendering the latter quite as sensitive to the detonating action of the minimum fulminate charge as undiluted gun-cotton. Moreover, the interesting fact has been conclusively established, that these compressed mixtures of gun-cotton with a nitrate or a chlorate are much less indifferent to the influence of detonating nitro-glycerine than gun-cotton in its pure state, chlorated and nitrated gun-cotton being detonated with certainty by means of ½ oz. of nitro-glycerine.

If compressed gun-cotton is diluted by impregnating the mass with a *liquid*, or with a solid which is introduced into the mass in a fused state, its susceptibility of detonation is reduced to a very much greater extent than by a corresponding quantity of a solid inert body, incorporated as such with the gun-cotton, the cause being the converse of that which operates in preventing a reduction of the sensitiveness to detonation of nitro-glycerine by its dilution with an inert solid. In this case the explosive liquid envelopes the solid diluent, and remains continuous throughout, occupying the spaces which exist between the solid particles; hence detonation is readily established and transmitted. But in the case of the solid explosive the diluent, which is liquid, or at any rate is introduced into the mass in the liquid state, envelopes each particle of the solid, so that a film of inert material surrounds each, isolating it from its neighbours, and thus opposing resistance to the transmission of detonation, which is proportionate to the original porosity or absorbent power of the mass.

While compressed gun-cotton, in the air-dry state, is detonated by 2 grains of mercuric fulminate imbedded in the material, its detonation by 15 grains, applied in the same manner, becomes doubtful when it contains 3 per cent. of water, over and above the 2 per cent. which exists normally in the air-dry substance. Specimens which had been impregnated with oil or soaked in melted fat and allowed to cool could not be detonated by means of 15 grains of fulminate. These diluted samples of gun-cotton could only be detonated by adding very considerably to the power of the initiative detonation; 100 grains of confined fulminate generally failed to detonate gun-cotton containing from 10 to 12 per cent. of water, and if the amount reached 17 per cent., 200 grains of fulminate were needed to insure its detonation.

But moist or wet compressed gun-cotton is decidedly more susceptible of detonation by (dry) compressed gun-cotton itself than by mercuric fulminate.

Thus 100 grains of dry gun-cotton, detonated through the agency of the ordinary fulminate fuze, suffice to detonate wet gun-cotton containing 17 per cent. of water, though this result is somewhat uncertain. If the diluting agent amounts to 20 per cent., detonation is not certain with less than 1 oz. of dry gun-cotton, and if the compressed material be completely saturated with water (*i.e.*, containing 30 to 35 per cent.), 4 oz. of the air-dry substance, applied in close contact, are needed to insure its detonation.

Detonation is transmitted through tubes from dry compressed gun-cotton to a moist disk of the material with the same facility as to the dry substance; and this is also the case with regard to the propagation of detonation from one mass of moist gun-cotton to another, in open air, all the pieces being ranged in a row, in contact with each other, provided that the piece first detonated does not contain less water than the others to which detonation is transmitted.

Gun-cotton containing 12 to 14 per cent. of water is ignited with much difficulty on applying a highly heated body. As it leaves the hydraulic press upon being converted from the pulped state to masses having about the density of water, it contains about 15 per cent. of water; in this condition it may be thrown on to a fire or held in a flame without exhibiting any tendency to burn; the masses may be perforated by means of a red-hot iron or with a drilling tool, and they may with perfect safety be cut into slices by means of saws revolving with great rapidity. If placed upon a fire and allowed to remain there, a feeble flame flickers over the surface of the wet gun-cotton from time to time as the exterior becomes sufficiently dry to inflame; and in this way a piece of compressed gun-cotton will burn away very gradually indeed. A pile of boxes containing in all 6 cwt. of gun-cotton, impregnated with about 20 per cent. of water, when surrounded by burning wood and shavings in a wooden building was very gradually consumed, the gun-cotton burning as already described when the surfaces of the masses became partially dried. Quantities of wet gun-cotton of 20 cwt. each, packed in one instance in a large, strong wooden case, and, in the other, in a number of strong packing cases, have been placed in small magazines, very substantially constructed of concrete and brickwork. Large fires were kindled around the packages in each building, the doors being just left ajar. The entire contents of both buildings had burned away, without anything approaching explosive action, in less than two hours. This comparatively great safety of wet gun-cotton, coupled with the fact that its detonation in that condition may be readily accomplished through the agency of a small quantity of dry gun-cotton, which, through the medium of a fulminate fuse or detonator, is made to act as the initiative detonating agent, gives to gun-cotton important advantages over other violent explosive agents for purposes which involve the employment of more or less considerable quantities

at one time, on account of the comparative safety attending its storage and the necessary manipulation of it. Moreover, it has been well established by experiments of many kinds carried out on a considerable scale, as well as by accurate scientific observations, that the detonation of wet gun-cotton is decidedly sharper or more violent than that of the dry material; a circumstance which affords an interesting illustration of the influence exerted by the physical condition of the mass upon the facility with which detonation is transmitted from particle to particle. In the determinations made by means of the Nobel chronoscope, of the velocity with which detonation is transmitted along layers or trains of gun-cotton and nitro-glycerine, the lecturer has included experiments with gun-cotton containing different proportions of water. When the material contained 15 per cent. of the liquid, some indications were obtained that the rate of transmission of detonation was a little higher than with dry gun-cotton; the difference was very decidedly in favour of wet gun-cotton, when the latter was thoroughly *saturated* with water. The air in the masses of compressed gun-cotton being replaced entirely by the comparatively incompressible body, water, the particles of explosive are in a much more favourable condition to resist displacement by the force of the detonation, and hence they are more readily susceptible of sudden chemical disintegration. Moreover, the variations in the rate of travel of detonation in dry gun-cotton, resulting from differences in the compactness or rigidity of different masses of the material, are very greatly reduced, if not entirely eliminated, by saturating the disks with water, and thus equalising their power of resisting motion by a sudden blow.

Another striking illustration of the influence which the physical character of an explosive substance exercises over its susceptibility to detonation and the degree of facility with which its full explosive force is developed, is furnished by one of the most recently devised, and one of the most interesting of existing, explosive agents.

Twelve years ago, soon after the process of producing compressed and granulated gun-cotton had been elaborated by the lecturer, it occurred to him to employ these forms of gun-cotton as vehicles for the application of nitro-glycerine. A considerable proportion of the liquid was absorbed by the porous masses of gun-cotton, and a nitro-glycerine preparation analogous in character to dynamite was thus obtained. The absorbent was in this case a violently explosive body instead of an inert solid as in dynamite, but the quantity of nitro-glycerine in a given weight of the preparation (to which the name of glyoxilin was given), was considerably less than in the kieselguhr-preparation; hence the latter was nearly on a point of equality with it, in regard to power, as an explosive agent.

(*To be continued.*)

NOTES FROM RUSSIA

GEOGRAPHY AND ANTHROPOLOGY.—At the last meeting, April 23, of the Imperial Russian Geographical Society, M. Sreznefsky, the Secretary, communicated his monthly report on the work of the Society. This consisted in equipping three expeditions in which the Society intends to take part, and its participation in the Anthropological Exhibition of Moscow. The first expedition is the cruise of the steamer *Nordenskjöld*, equipped by the well-known merchant of Siberia M. Sibiriakoff, for the relief of Prof. Nordenskjöld in the *Vega*. It will proceed from Malmö direct to Yokohama, Behring Strait, and beyond. According to the request of M. Sibiriakoff the Society appointed to accompany the expedition M. A. W. Grigorieff, an accomplished botanist, known for his dredging work in the White Sea, where he collected very interesting specimens of marine fauna with deep soundings and temperature observations, by means of a Negretti and Zambra deep-sea thermometer. He proceeds to Malmö to join the expedition, with a Dent chronometer from the Society, and a complete provision for zoological collections, and a sufficient provision of alcohol.

The second expedition is sent out by the Ministry of Public Works, for the exploration of the old bed of the Amu-daria (Usboi), and to investigate the possibility of turning the river to the Caspian; it will be under the direction of Major-General A. T. Gloukhofskoi, an experienced traveller in Central Asia. The Society sends two Fellows with the expedition, a geologist, Prince Sedroiz, and the economist, N. A. Majef, the manager of the *Turkestan News*, a collector of varied statistical materials in Turkestan. The third expedition, of a private character, is to explore for a railroad from Orenburg to Tashkent, and the possibility of navigating with steamers the Sir and Amu-daria. By order of the Emperor a sum of 5,000 roubles is placed at the disposal of the Society

The Anthropological Exhibition was opened in Moscow on April 15, under the superintendance of the Society, which has sent a great number of valuable objects of an ethnological character, with craniological collections and prehistorical specimens, tumuli excavations, and a valuable collection belonging to the Czarevich. All these collections were arranged by M. Sreznefsky, the Secretary of the Society, who was sent as its representative to the opening of the exhibition. The aim of this exhibition is: (1) To contribute to the development of anthropology as a science. (2) The foundation of an anthropological museum for the teaching of anthropology in the University of Moscow. (3) To popularise the science.

The exhibition is divided into sections—prehistorical, anthropological, medico-anthropological, photographical, ethnographical, the history of Russian types.

At the end of the meeting of the Society M. Alenitzin communicated his paper on the history of the Amu-daria question; he criticised the different opinions on the possibility of turning the Amu-daria into the Caspian, and doubted whether this question could be resolved practically and in a positive manner.

A. LOMONOSSOFF

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Council of the Society of Arts having received an application from the City and Guilds of London Institute for the Advancement of Technical Education, offering to take charge of the technological examinations established by this Society in 1873, and carried on to the present time, have resolved to transfer these examinations to the charge of the Institute. The Council have also ascertained that the Science and Art Department will assist the City Institute in conducting the examinations, in the same way as it has hitherto assisted the Society of Arts. The technological examinations for the present year will, therefore, be carried on under the direction of the Institute, and all communications on the subject should be addressed to the Hon. Secretaries, City and Guilds of London Institute, Mercer's Hall, E.C.

THE following is the result of the recent examination for the Public Schools Prize Medals of the Royal Geographical Society: Physical Geography (examiner John Ball, F.R.S.), gold medal, Matthew George Grant; silver medal Frank Taylor Sharpe, both of Liverpool College. Honourably mentioned: E. G. Harmer, University College School; H. Ll. Smith, Bristol Grammar School; F. S. Carey, Bristol Grammar School; A. T. MacConkey, Liverpool College. Political Geography (examiner Canon Tristram, F.R.S.), gold medal, David Bowie, Dulwich College. Silver medal, Claude L. Bickwell, Harrow School. Honourably mentioned, J. F. Naylor, Dulwich College; W. H. D. Boyle, Eton; A. D. Rigby, Liverpool College; Theod. Brooks, London International College; R. A. Fawcett and A. C. Painter, of Clifton College.

ON May 1 an interesting ceremony took place at St. Barbe, the principal free institution at Paris. Two bodies of pupils were marched under the direction of teachers; the first was going to the Gare du Nord in order to come to London and spend six months in a corresponding English institution to learn the English language; the other went to the Gare de l'Est to proceed to Germany. These pupils have already learned foreign languages in Paris. They are placed under the supervision of professors, so that the usual routine of their studies for French honours should not be interrupted in any way.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 3.—In view of contradictory results got by Sir W. Thomson and M. Le Roux, with regard to the thermo-electric behaviour of stretched wires, Herr Cohn has made a number of experiments, here described in an inaugural dissertation. He finds that the intensity of the thermo-current between stretched and unstretched wire of the same metal, depends (apart from all *permanent* properties), not only on the present tension of the former, but also, in very different

degree according to the material used, on the upper and lower limits between which, since the last complete release from tension, the tensions have varied (the *succession* alone, not the *time*, being here determinant). In a thermo element of two similar wires, stretched with equal weights, but of which one (a) has last borne a greater, the other (b) a less weight, the current flows from b to a. In iron and steel the previous tensions even affect the direction in which the thermo-current varies with increasing or decreasing tension. Taking the direction of the current which arises with the *first* weak stretching, it is opposite for hard and soft wires, and the discordance above referred to is thus explained. Herr Cohn thus formulates his general conclusion: "A stretched wire behaves, *ceteris paribus*, differently, according as it has before been stretched more weakly or more strongly, and this difference continues till the next alteration of the tension."—Herr R. Weber contributes a useful paper on the chemical composition of glasses with relation to their resistance to atmospheric influences. He finds that the composition of many well tested lime alkali glasses approximates the proportions $6SiO_2$, $1CaO$, and $1K_2O$ or Na_2O; but also, in good glasses, there may be more alkali, if it be compensated with more than 6 equivalents of silicic acid; and less silicic acid may be allowed if the lime be diminished relatively to the alkali.—The transmission of high tones through the telephone is discussed by Herr Hagenbach. From his experiments it appears that the (upper) limit of audibility with the instrument is commonly about two octaves lower than in direct hearing. The cause is found not in the line, nor in the magnet, but in the plate, which, when the variations of magnetism exceed a certain number per second, no longer keeps up with them.—Herr Aron gives a mathematical study of the microphone; *inter alia*, it is shown that, whereas in the telephone the "clang tint" is exalted, in the microphone it is lowered.—Herr Herwig prosecutes his study of liquid cells as condensers; considering the charge of cells, first by large constant batteries, then by small forces (both acting shortly), and comparing the full charges in cells containing liquids of different resistances.—We further note a new hygrometer by Herr Edelmann, based on the fact that if any space be filled with atmospheric air, and the aqueous vapour then removed, without altering the volume, the pressure decreases by the amount of tension of this vapour. A sinus manometer for measuring small differences of air-pressure (Thomsen), and a simple regulator for the electric light (Stöhrer) are also described.—Herr Fröhlich shows the bearing of the principle of conservation of energy on the theory of diffraction.

THE *Rivista Scientifico-Industriale*, (1879, No. 7) contains the following papers of interest:—On some prehistoric discoveries in Sicily, by Prof. Francesco Mangini.—On the lengthening of filiform conductors traversed by an electric current, by Prof. G. Basso.—On the optic rotatory power of quartz and its variation with temperature, by M. Joubert.—On digallic acid, by Prof. U. Schiff.—On some phenomena due to the viscosity of liquids, by Prof. Carlo Marangoni.—On Sargasso seas, by the same.—On Helmholtz' double siren, by the editor.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 20 and 27, and April 3.—"On the Reversal of the Lines of Metallic Vapours," Nos. iv., v., and vi., by Professors Liveing and Dewar.

In the first of these experiments the metals were produced by chemical reactions within the tubes, used as before described. They found that cæsium chloride alone heated in glass tubes gave no absorption lines, but cæsium and rubidium chlorides when heated with metallic lithium each showed its characteristic absorption lines. Charred tartrate of cæsium heated in a furnace in a narrow porcelain tube gave very readily the two lines in the blue reversed, and charred rubidium tartrate the two violet lines reversed, but no reversal in any other part of the spectrum. When charred potassium tartrate was treated in the same way, a broad absorption band was seen extending from wave-length about 5,700 to about 5,775. This band was also seen for a short time bright, when the material was put into the tube before it was heated, and the light observed as the tube got hot. It was also seen bright in the induction-spark taken between platinum and potassium in carbonic oxide. Besides this band the vapours from the charred potassium tartrate produced another absorption band in the red, and two more in the blue. None of these absorptions correspond with those seen when potassium is heated in hydrogen, or with known emission lines of that metal, though the first and most conspicuous is near a well-known group of three bright lines of potassium. Charred sugar mixed with carbonate of soda gave only the same absorption as sodium in hydrogen. A mixture of barium carbonate, lamp-black, and aluminium filings gave dark bands corresponding to the bright bands seen when sparks are taken from a solution of barium chloride marked α, β, and δ respectively by Boisbaudran; and at the highest temperature of the furnace fed with Welsh coal a mixture of charred barium tartrate and aluminium gave the barium line wave-length 5535 sharply reversed. Charred strontium and calcium tartrates with aluminium gave no reversals, but with the addition of sodium or potassium carbonate the well-known blue line of strontium and violet line of calcium were reversed. The temperature at which these results were obtained was reached by the use of gas retort carbon as fuel, and was such that iron tubes well coated with fire-clay gave way in a few minutes.

The next experiments were made with tubes bored out of lime and heated at the bottom by a jet of coal-gas and oxygen introduced through a lateral opening. In these, as in the previous experiments, the hot bottom of the tube itself (not an independent light as used by Messrs. Lockyer and Roberts in their experiments with lime tubes) gave the luminous background. In this way the violet line of calcium was reversed, the red line of lithium and the orange and green bands of lime appeared with dark lines down their middles.

A larger series of experiments was made with similar tubes of lime, but with an electric arc introduced through lateral openings as the source of light and heat. In some cases a tube bored in a block of gas carbon was employed, and was then made one of the electrodes. The carbon tubes, however, were found to conduct away the heat, and though they lasted much longer, did not in general succeed so well as the lime tubes. In same cases aluminium was used as a reducing agent, and in others more volatile substances, viz., potassium and sodium carbonates, were used to increase the amount of vapour carried up into the tube; and in others a current of hydrogen was introduced.

Of the calcium lines the violet line (4226) was almost always seen expanded with a dark middle, and the three brightest lines in the indigo were often in a similar condition. The addition of aluminium generally made them appear as dark bands on a continuous background. Of the two Fraunhofer lines H, the more refrangible (K) was the first to appear reversed, and remained so the longer. Other calcium lines reversed were, one in the green (5188), and, much less easily, two in the red (6161, 6121), one more in the indigo (4302), and one in the blue (4877).

In the case of strontium, the well-known blue line was easily reversed, and two lines in the violet (4215, 4077), less easily five lines in the blue (4812, 4831, 4868, 4873, 4895), and, by the aid of aluminium, one in the green (4962). In the case of barium, besides the persistent ray 5535, two other lines in the green (5518, 4933), a line in the blue (4553), and one in the orange (6496), were reversed.

With magnesium the b group were expanded and reversed in an order the inverse of their refrangibility. The other lines of that metal were expanded, but not reversed, and the blue line, 4481, conspicuous in the spark between magnesium electrodes, was not seen at all. This line does not appear in Capron's photographs of magnesium in arc. An attempt to re-introduce it by combining the action of an induction spark with that of the arc in a lime tube failed owing to the conducting power of the hot gases and walls of the tube, and will probably only succeed with a pressure of several atmospheres in the apparatus. The similar disappearance of the cadmium lines 5377 and 5336 was also noticed.

In using potassium carbonate the two extreme pairs of lines, in the violet and red respectively, were readily reversed; less readily the three lines in the greenish-yellow, other two lines in the red (6913, 6946), a group of three in the orange (5353, 5338, 5322), and the least refrangible (5112) of another triplet in the green.

Using sodium chloride, the pair of lines next more refrangible than D were repeatedly reversed, the less refrangible being the first and most strongly reversed, as has also been observed by Mr. Lockyer. A second pair of bright lines usually came out at the same time, like ghosts of the first, on the more refrangible side.

With lithium chloride, the red and blue lines were easily re-

versed, the orange line well reversed, and the green, though with difficulty, distinctly reversed; the violet line, much expanded, showed no reversal. The authors conclude that the green line really belongs to lithium, and not to cæsium, since the blue lines of the latter metal, so easily reversed, never appeared.

In the case of rubidium, the more refrangible of the red lines was seen as a black line on a continuous background, but this background of light did not extend so low as to allow the reversal of the extreme ray of rubidium to be observed.

With metallic indium the two characteristic lines were seen strongly reversed, but no other; metallic gallium also gave its two characteristic lines reversed, the more refrangible being the less strongly so.

Aluminium gave no reversal of any of its lines, except the two between the Fraunhofer lines H. It was noticed that the addition of aluminium to either copper or silver in the lime tubes caused the copper or silver lines, previously predominant, to fade, while the calcium lines came out instead with marked brilliance.

Reviewing the series of reversals which they have observed, the authors remark that in many cases the least refrangible of two lines near together is the most easily reversed, as has been previously remarked by Cornu. Thus, in the case of barium (though there is no very distinct grouping of the lines of that metal), taking the rays in order, the line wave-length 5535 is readily reversed, while that with wave-length 5518 is less easily reversed; the line wave-length 4933 is comparatively easily reversed, whereas that with wave-length 4899 has not been reversed. On the other hand, the line wave-length 4553 has been reversed, but not the line wave-length 4524. In the case of strontium, the lines wave-length 4831 and 4812 have been reversed, but not the line wave-length 4784, and the two lines wave-length 4741 and 4721 remain both unreversed. In the group of five lines of calcium, wave-length 4318 to 4282, it is only the middle line wave-length 4302 which has been reversed. Of the potassium groups of lines wave-length 5829 and 5811, 5802, 5782, the line wave-length 5811 has not been reversed, and of the others the line wave-length 5802 is the first to appear reversed. It is worthy of remark that the first of these lines is faint and the last is the brightest of the group. The group wave-length 5353, 5338, 5322 have been all reversed, but the last of the three (5322) was the most difficult to reverse: it is also the feeblest of the group. In the more refrangible group, wave-length 5112, 5092, 5078, the least refrangible is the only one reversed.

Making a general summary of their results respecting the alkaline earth metals, potassium and sodium, and having regard only to the most characteristic rays, which for barium they reckon as 21 in number, for strontium 34, for calcium 37, for potassium 31, and for sodium 12, the reversals in their experiments number respectively 6, 10, 11, 13, and 4. That is in the case of the alkaline earth metals about one-third, and these chiefly in the more refrangible third of the visible spectrum; the number of characteristic rays remaining unreversed in the more refrangible part of the spectrum being respectively 2, 5, and 4. In the case of potassium they reversed two in the upper third, all the rest in the least refrangible third. These experiments relate to mixtures of salts of these metals combined with the action of reducing agents.

In a table the authors show the relation between their observations on reversals and Young's on the chromospheric lines.

The authors point out that in Young's catalogue the green coronal line (wave-length 5316) is almost as frequently present in the chromosphere as the lines numbered 1 and 82, and D_3 which he suggested might belong to one substance, and they think that the four lines may all belong to the same substance; and they call attention to certain analogies in the ratios of the wave-lengths of these four lines to those of the lines of hydrogen, lithium, and magnesium.

April 24.—"On the Nature of the Fur on the Tongue," by Henry Trentham Butlin, F.R.C.S.

Tongue-fur consists chiefly of (1) *Débris* of food and bubbles of mucus and saliva. (2) Epithelium. (3) Masses which appear at first to consist of granular matter, but which are the glœa of certain forms of schistomycetes. That the last-named of these three is the essential constituent is proved by the fact that the quantitity of the glœa corresponds roughly with the quantity of fur present, and that its position upon the tongue corresponds exactly with that of the fur, both covering the tops of the filiform papillæ, but not usually lying between them.

In order to ascertain the true nature of the glœa, and to obtain it in a purer form, it was cultivated upon a warm stage. Several fungi were discovered, but only two of these were present in every instance, *Micrococcus* and *Bacillus subtilis*; and, as the glœa produced artificially was similar to that existing naturally in the tongue-fur, it is believed that fur is composed essentially of these two fungi. *Micrococcus* developed freely and abundantly, forming large masses of yellow or brownish-yellow colour. *Bacillus* did not develop, but existed in greater or less abundance in all the cases examined. Its development was probably prevented by the presence of other developing organisms, from which it was found impossible to separate it. It appeared to be identical with the *Leptothrix buccalis* of Robin. Although it did not develop under artificial conditions, it is probable that development takes place freely upon the surface of the tongue. Its habitual occurrence there, and the presence of spore-bearing filaments favour this view.

Besides these fungi there were present, more or less constantly, *Bacterium termo*, *Sarcina ventriculi*, *Spirochæta plicatilis*, and a larger form of *Spirillum* (or rather *Vibrio*). *Sarcina ventriculi* was frequently present, and generally developed quickly, forming large masses of a yellow or yellowish-brown colour. *Spirochæta plicatilis* occurred only in two or three of the specimens examined. *Bacterium termo* existed in some of the furs, and twice developed with such rapidity that the whole of the fluid was crowded with these organisms.

The slime between and around the teeth was found to consist of the same fungi as the tongue-fur, but the rods of Bacillus were longer, probably owing to the disturbing causes being fewer.

Physical Society, April 26.—Prof. W. G. Adams in the chair.—Mr. C. V. Boys gave an account of some experiments made by Dr. Guthrie and himself on the subject of Arago's rotation. The experiments were begun with a view to determine if the drag on a copper disk when a magnet is made to revolve beneath it, or on the magnet if the disk is made to revolve above it, could be made use of for determining the velocity of running machinery. They made the magnet revolve, and obtained the angle of deflection of a disk suspended by a torsion thread (the hair-spring of a watch). They found, as Snow, Harris, and others found before, that other things being equal, the drag is directly proportional to the speed, so that if the torsion of the thread could be relied on, and the strength of the magnet did not change, a perfect velocimeter could be constructed. They consider that this method is better than observing the deflection of a magnet over a revolving disk, as in this case they are limited to less than a right angle, and changes in the absolute magnetism of the earth would affect the results. They also determined the effect of change of distance, thickness, diameter, and nature of the disk, &c., their results agreeing with those of former experiments. They observed that the effect of concentric circular cuts was far greater than that of even many radial cuts, and that when radial sectors were entirely separated from each other, the effect was much less than when these were united at the centre. They then experimented on liquids by suspending a sphere or cylinder of the liquid between the poles of a revolving electromagnet, and succeeded in getting a decided and measurable effect. The importance of this is very great, for they have thus a means of determining the conductivity of liquid electrolytes by currents induced in the liquid without the use of electrodes, and without polarisation.—Dr. Guthrie stated that as the push on the liquid is directly proportional to the current quantity, they hope to measure the conductivities of liquids, and connect these to the conductivity of solids through the intervention of mercury. In reply to Prof. Adams Mr. Boys said that the angle of deflection of the conductor had proved to be proportional to its conductivity. Dr. O. J. Lodge suggested that the conductivity of the disks used in these experiments should be determined by plotting out the equipotential surfaces. Dr. Sylvanus Thomson recommended trying conducting jellies in these experiments, and Dr. Guthrie replied that such were being prepared for trial, including the permanent jelly made by dissolving gelatine in anhydrous glycerine at 100°.—Prof. Sylvanus Thomson then communicated five laboratory notes from University College, Bristol. The first related to the source of sound in the Bell telephone receiver. Two theories are now being discussed as to this effect, the molar theory regards the motion of the diaphragm-mass as the source of sound, the molecular theory finds it in the molecular motions of the mag-

netic core of the instrument. Prof. Thomson applied his method of getting magnetic curves with iron filings dusted on gummed glass to this problem. He found that when no currents passed in the telephone the magnetic lines springing from the pole of the magnet are gathered together on the diaphragm opposite over a central region, which is magnetised lamellarly or like a magnetic shell. The rim of the plate beyond this region is, however, magnetised radially, and between these two zones there is a neutral circle. It was remarkable too that the lines of force touching the plate were bent back around this circle, forming a kind of valley. When the current passed in the coil, in a direction so as to reinforce the magnetism, the lines are gathered more closely on the central region of the plate. If the current diminishes the magnetism the lines are, on the other hand, repelled from the plate. The neutral ring is also altered. In the first case it shrinks in size, in the second it expands. A small thick disk is wholly magnetised lamellarly; a disk entirely magnetised radially becomes slightly conical in shape. In the actual telephone the disk is flat at the middle and conical at the edges. As the current varies the diaphragm will assume new nodal lines. Dr. Thompson concludes that the molecular theory is not therefore necessary to account for the speech of the telephone, although it may assist. As confirming this view, he found that with iron rings round a cardboard diaphragm, and an iron centrepiece, the enunciation was good, though the timbre was altered, whereas with radial pieces of iron on the cardboard, the timbre was good but the enunciation bad. In reply to Prof. Adams, Dr. Thompson said that the stronger the magnet the shorter the lamellarly magnetised space became, and that with a thicker disk the neutral ring was not so well marked. Dr. Lodge suggested that the best place for the coil would be in the valley over the neutral ring, which was in an unstable condition. Dr. Thompson next wrote on a saw-blade with a magnet and dusted iron filings on it, which arranged themselves so as to trace the writing. This is usually shown on a steel plate, but a saw retains the virtue for six or eight months. A modification of this experiment, due to himself, consisted in writing on the blade with one pole of a powerful battery, the other pole being connected to the end of the blade. The third "note" recommended the use of fine steel fibres, got by breaking iron gauze of 32 meshes to the inch, instead of iron filings, for exhibiting magnetic lines. The fourth note showed that the lines of force got by filings fixed on cards are magnetic, that of a bar-magnet acting as a magnet. The fifth note explained that solid magnetic "figures" could be got by coating iron filings in shellac to make them light, and floating them in water; or by mixing filings in a soft paste of plaster of Paris, which could be cut into sections on hardening.

Chemical Society, May 1.—Dr. Warren de la Rue, president, in the chair.—The following papers were read:—On the volumes of liquids at their boiling-points obtainable from unit volumes of their gases, by Dr. W. Ramsay. The author has suggested the use of a thin glass bulb filled with the liquid, and heated in its own vapour until expansion ceases, the bulb is then allowed to cool, and is weighed; thus the volumes of many liquids at their boiling-points, "ebullition volumes," has been determined by the author. His results agree closely with those obtained by Kopp; the time required for a determination is half an hour.—On a method of precipitating manganese as dioxide, and its application to the volumetric determination of manganese, by J. Pattinson. Manganese in solution can be completely precipitated as dioxide by bleaching-powder solution or bromine water, if an equal quantity of iron, as ferric chloride, be present. The dioxide is then dissolved in dilute sulphuric acid, reduced by standard ferrous sulphate and titrated with bichromate.—On the determination of nitric acid as nitric oxide by means of its action on mercury, by R. Warington. In this well-known process of Crum and Frankland the author has found that the removal of the chlorides is unnecessary, and that small quantities of organic matter, except cane sugar, do not interfere with the results.—On a new class of colouring-matters, by Dr. O. N. Witt. By oxidising a mixture of metatoluylene diamine and dimethylparaphenylendiamin in aqueous solution, the author has obtained several new colouring-matters, toluylen blue, violet, pink, &c.

Institution of Civil Engineers, April 29.—Mr. Bateman, F.R.S., president, in the chair.—The first paper read was on street carriageway pavements, by Mr. George F. Deacon, M. Inst. C.E.—The second paper read was on wood as a paving material under heavy traffic, by Mr. O. H. Howorth, Assoc. Inst. C.E.

EDINBURGH

Royal Society, April 21.—On the anatomy of the northern Beluga (*B. catodon*) compared with that of other whales, by Morrison Watson, M.D., and Alfred H. Young, M.B., of the Owens College, Manchester.—This paper contains a complete account of the visceral anatomy of *Beluga*. In connection with the larynx, the existence of pouches similar to those previously described by Murie in Risso's Grampus is pointed out. These pouches undoubtedly correspond to the large laryngeal air-sac of the whalebone whales; both are regarded by the authors as homologous with the ventricles of Morgagni of other mammals, and not, as considered by previous anatomists, with the well-marked air-sacs met with in several species of quadrumana.

BOSTON, U.S.A.

American Academy of Arts and Sciences, April 9.—Hon. Charles Francis Adams in the chair.—Prof. Benjamin Peirce presented a paper on the meteoric constitution of the solar system, in which the existence of a meteoric shell outside of the planetary system is maintained. The meteors, in falling from this shell, would be subject only to the attractions of the sun and planets. The motions of the larger meteors or comets were discussed, and some remarkable agreements of observed facts with the theory were shown.—Prof. Pickering described a new form of transit instrument for measuring the light of the stars. Much of the time spent when using other photometers in identifying the object is thus saved. The stars are compared directly with the pole-star, and the variations of an artificial star are thus avoided. At the Harvard College Observatory the measurement of the light of about 4,000 stars of the sixth magnitude and highest, has been undertaken with this instrument. Each star will be observed on three nights, and two sittings will be made each evening.—A paper on the action of bromine on substituted toluols was presented by Prof. C. Loring Jackson and Mr. A. W. Fields.—Mr. W. W. Jacques, of Johns Hopkins University, Baltimore, presented the results of an investigation into the distribution of heat in the spectra of various sources of radiation. The distribution of heat in the spectrum of a solid or liquid source of radiation was found to be nearly independent of the temperature of the source. Dr. Draper's conclusion that "It necessarily follows that in the spectrum any two equivalent series of undulations will have the same heating power, no matter what their actual wave-length may be," was found to be not correct.

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